CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

4. ENVIRONMENTAL CONSEQUENCES

4.1. IMPACT-PRODUCING FACTORY AND SCENARIO — ROUTINE OPERATIONS

4.1.1. Offshore Impact-Producing Factors and Scenario

This section describes the offshore infrastructure, activities, and disturbances associated with the proposed actions in the Central Planning Area (CPA) and Western Planning Area (WPA) and with the Gulfwide OCS Program that could potentially affect the biological, physical, and socioeconomic resources of the Gulf of Mexico. Offshore is defined here as the OCS portion of the Gulf of Mexico that begins 10 mi offshore Florida; 3 mi offshore Louisiana, Mississippi, and Alabama; and 3 leagues offshore Texas; and it extends seaward to the limits of the Exclusive Economic Zone (EEZ) (Figure 4-1). Coastal infrastructure, activities, and disturbances associated with the proposed actions and the OCS Program are described in Chapter 4.1.2.

Offshore activities and disturbances are described in the context of proposed action scenarios and an OCS Program scenario. The MMS, Gulf of Mexico OCS Region, developed these scenarios to provide a framework for detailed analyses of potential impacts of the proposed lease sales. Each scenario is a hypothetical framework of assumptions based on estimated amounts, timing, and general locations of OCS exploration, development, and production activities and facilities, both offshore and onshore. The proposed actions analyzed in this EIS are presented as a set of ranges for resource estimates, projected exploration and development activities, and impact-producing factors. The scenarios do not predict future oil and gas activities with absolute certainty, even though they were formulated using historical information and current trends in the oil and gas industry. Indeed, these scenarios are only approximate since future factors such as the contemporary economic marketplace, the availability of support facilities, and pipeline capacities are all unknown. Notwithstanding these unpredictable factors, the scenarios used in this EIS represent the best assumptions and estimates of a set of future conditions that are considered reasonably foreseeable and suitable for presale impact analyses. The development scenarios do not represent an MMS recommendation, preference, or endorsement of any level of leasing or offshore operations, or of the types, numbers, and/or locations of any onshore operations or facilities.

The assumed life of the leases resulting from a proposed sale does not exceed 40 years. This is based on averages for time required for exploration, development, production life, and abandonment for leases in the Gulf of Mexico. For the cumulative analysis, the OCS Program is discussed in terms of current activities, current trends, and projections of these trends into the reasonably foreseeable future. For modeling purposes and quantified OCS Program activities, a 40-year analysis period (year of the first WPA lease sale through 34 years after the last CPA sale as proposed in the 5-Year Program for 2002-2007) is used. Activity projections become increasingly uncertain as the length of time for projections are made increases and the number of influencing factors increases. The projections used to develop the proposed actions and OCS Program scenarios are based on resource and reserves estimates as presented in the *2000 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf as of January 1, 1999* (Lore et al., 2001), current industry information, and historical trends.

The statistics used for these historic trends exhibit a lag time of about two years; therefore, the models using the trends also reflect two-year-old statistics. In addition, the overall trends average out the "boom and bust" nature of Gulf of Mexico OCS operations. The models cannot fully adjust for short-term changes in the rates of activities. In fact, these short-term changes should not be projected into the long term. An example of a short-term change was the surge in deepwater activities in the mid-1990's as a result of technological advancements in seismic surveying and development options, as well as a reflection of deepwater royalty relief. This short-term effect was greater than the activity level predicted by the resources and socioeconomic models. The MMS believes that the models, with continuing adjustments and refinements, adequately project Gulf OCS activities in the long term for the EIS analyses.

The proposed actions and the OCS Program scenarios are based on the following factors:

- recent trends in the amount and location of leasing, exploration, and development activity;
- estimates of undiscovered, unleased, conventionally recoverable oil and gas resources in the planning area;
- existing offshore and onshore oil and/or gas infrastructure;
- industry information; and
- oil and gas technologies, and the economic considerations and environmental constraints of these technologies.

The proposed actions in the CPA are Central Gulf Lease Sales 185, 190, 194, 198, and 201, as scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007*. In general, a proposed CPA lease sale represents 1.8-2.9 percent of the OCS Program in the CPA based on barrels of oil equivalent (BOE) resource estimates. Activities associated with a proposed lease sale in the CPA are assumed to represent 1.8-2.9 percent of OCS Program activities in the CPA unless otherwise indicated. In general, a proposed CPA lease sale represents 2 percent of the Gulfwide OCS Program based on BOE resource estimates. Activities associated with a proposed action are assumed to represent 2 percent of Gulfwide OCS Program activities and impacts unless otherwise indicated.

The proposed actions in the WPA are Western Gulf Lease Sales 187, 192, 196, and 200, as scheduled in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007*. In general, a proposed WPA lease sale represents 2.6-3.3 percent of the OCS Program in the WPA based on BOE resource estimates. Activities associated with a proposed action are assumed to represent 2.6-3.3 percent of OCS Program activities in the WPA unless otherwise indicated. In general, a proposed WPA lease sale represents 1 percent of the Gulfwide OCS Program based on BOE resource estimates. Activities associated with a proposed lease sale in the WPA are assumed to represent 1 percent of Gulfwide OCS Program activities and impacts unless otherwise indicated.

Specific projections for activities associated with the proposed actions are discussed in the following scenario sections. The potential impacts of the activities and disturbances associated with the proposed actions are considered in the environmental analysis sections (Chapters 4.2, 4.3, and 4.4).

The Gulfwide OCS Program resource and reserve estimates and projected activity levels for this multisale EIS are substantially different than those for the last multisale EIS's (the multisale EIS for the 1998-2002 CPA lease sales and the multisale EIS for the 1997-2002 WPA lease sales). There are several reasons for these changes. The MMS recently completed an assessment of Gulf OCS resources — the *2000 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf as of January 1, 1999* (Lore et al., 2001). This assessment is based on geophysical data collected with new technologies allowing increased penetration and resolution, as well as on the latest available engineering and well bore information. This 2000 assessment resulted in a more than 200 percent increase in total Gulf of Mexico undiscovered conventionally recoverable hydrocarbon resources prompting similar changes in exploration and development activity levels used in this multisale EIS.

Projections for OCS Program installations and removals of structures have changed dramatically. Structures include all sea-surface-piercing facilities, ranging from single well caissons to large deepwater hubs and subsea development systems. The projections for this multisale EIS scenario are based on the application of historical platform installation and removal trends to annual production rate projections. The annual production rates more closely reflect the "profile" of a developing and then maturing hydrocarbon province, while the historic trends are more reactive to the cyclic changes in the economic environment. The previous projections were for a 9-23 percent net increase from the nearly 4,000 platform structures currently operating in the Gulf of Mexico, with 985-1,865 installations and 620-925 removals during the 40-year analysis period. Projections for the current EIS are for a net decrease of more than 80 percent in operational structures by the end of the 40-year analysis period, with 2,987-3,999 installations and 6,316-7,322 removals projected.

For the previous multisale EIS's, the range of annual production rates were projected to decrease from 1,530-1,597 million barrels of oil equivalent per year (MMBOE/yr) in 2002 to 319-537 MMBOE/yr in 2036. For the current multisale EIS, range of annual production is projected to decrease from 1,469-1,477 MMBOE/yr in 2002 to 427-812 MMBOE/yr by the end of the 40-year analysis period.

Many factors influencing the rate of platform installation and removals have changed in recent years. Platform removals are projected to outpace installations as the aging population of a large number of small production platforms and single well caissons on the shelf are decommissioned while fewer, deepwater structures are installed. These deepwater production host facilities may handle production throughput equivalent to 50 typical platforms on the continental shelf. These host facilities are much larger to accommodate the production and processing equipment for the greater throughput as well as accommodations for the large crews required. As the cost of multiplexed umbilicals increase, there is a trend toward "minimal structures" in deepwater. These minimal structures are essentially large buoys designed to provide remote control capabilities for the subsea systems and to provide chemical injection operations. Some of the minimal structures may also have helipads.

Additional structures are projected for installation on the continental shelf to develop deep gas. New discoveries for deep gas offer the best short-term opportunity for achieving the large reserve additions and flow rates to offset declining gas production (USDOI, MMS, 2001b). Sediments at greater than 15,000 ft below sea level and in less than 200 m water depth are relatively unexplored. Only 5 percent of all wells on the OCS have drilled to sediments below 15,000 ft subsea. The MMS estimates that there could be 5-20 tcf with the most likely value at 10.5 tcf of deep gas recoverable resources below 15,000 ft. In order to achieve economic success, deep wells require larger structures and must therefore have higher flow rates to compensate for the higher drilling costs. Wells into deep gas reservoirs on the Gulf of Mexico continental shelf encounter high temperatures, high pressures, and high corrosive content, all of which add to higher costs for drilling and production. The MMS offered incentives to operators in the form of royalty relief on deep gas production from any new leases issued in Lease Sale 178 (March 2001). Such royalty relief may well be extended to deep gas production on other existing and future leases.

The OCS Program scenario includes all activities that are projected to occur from past, proposed, and future lease sales during the analysis period. Activities that take place beyond the analysis timeframe as a result of future sales are not included in this analysis. The impacts of activities and disturbances associated with the OCS Program on biological, physical, and socioeconomic resources are analyzed in the major cumulative action analyses (Chapter 4.5).

4.1.1.1. Resource Estimates and Timetables

4.1.1.1.1. Proposed Actions

The proposed action scenarios are used to assess the potential impacts of the proposed lease sales. The resource estimates for the proposed actions are based on two factors: (1) the conditional estimates of undiscovered, unleased, conventionally recoverable oil and gas resources in the proposed lease sale areas; and (2) estimates of the portion or percentage of these resources assumed to be leased, discovered, developed, and produced as a result of the proposed actions. The estimates of undiscovered, unleased, conventionally recoverable oil and gas resources are based upon a comprehensive appraisal of the conventionally recoverable petroleum resources of the Nation as of January 1, 1999. Due to the inherent uncertainties associated with an assessment of undiscovered resources, probabilistic techniques were employed and the results were reported as a range of values corresponding to different probabilities of occurrence. A thorough discussion of the methodologies employed and the results obtained in the assessment are presented in the MMS report *2000 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf as of January 1, 1999* (Lore et al., 2001). The estimates of the portion of the resources assumed to be leased, discovered, developed, and produced as a result of the proposed actions are based upon logical sequences of events that incorporate past experience, current conditions, and foreseeable development strategies. A profusion of historical databases and information derived from oil and gas exploration and development activities are available to MMS and were used extensively. The undiscovered, unleased, conventionally recoverable resource estimates for the proposed actions are expressed as ranges, from low to high. The range reflects a range of projected economic valuations of the produced oil and gas. The "low" end of the range is based on an economic case of $18 per barrel of oil and $2.11 per thousand cubic feet (Mcf) for gas. The "high" estimate is based on an economic case of $30 per barrel of oil and $3.52 per Mcf for gas.

Table 4-1 presents the projected oil and gas production for the proposed actions and for the OCS Program. Tables 4-2 and 4-3 provide a summary of major elements of a proposed action scenarios and some of the related impact-producing factors. To analyze impact-producing factors for the proposed actions and the OCS Program, the proposed lease sale areas were divided into offshore subareas based upon ranges in water depth. Figure 4-1 depicts the location of the offshore subareas. The water depth ranges reflect the technological requirements and related physical and economic impacts as a consequence of the oil and gas potential, exploration and development activities, and lease terms unique to each water-depth range. Estimates of resources and facilities are distributed into each of the subareas.

The estimated amounts of resources projected to be leased, discovered, developed, and produced as a result of a proposed lease sale are 0.276-0.654 BBO and 1.590-3.300 tcf of gas for a CPA lease sale, and 0.136-0.262 BBO and 0.810-1.440 tcf of gas for a WPA lease sale. The number of exploration and delineation wells, production platforms, and development wells projected to develop and produce the estimated resources for the proposed actions are given in Tables 4-2 and 4-3. The tables show the distribution of these factors by offshore subareas in the proposed lease sale areas. Tables 4-2 and 4-3 also include estimates of the major impact-producing factors related to the projected levels of exploration, development, and production activity.

For purposes of analysis, the life of the leases resulting from the proposed actions is assumed to not exceed 40 years. Exploratory activity takes place over a 25- to 34-year period, beginning in the year of the lease sale. Development activity takes place over a 35-year period, beginning with the installation of the first production platform and ending with the drilling of the last development wells. Production of oil and gas begins by the fourth year after the lease sale and continues through the 38th year. Final abandonment and removal activities occur in the last two years.

4.1.1.1.2. OCS Program

Gulfwide OCS Program: Estimates of total reserve/resource production related to a proposed action plus prior and future sales in the entire Gulf of Mexico OCS (CPA,WPA, and EPA) over the 40-year analysis period -are 15.49-22.42 BBO and 153.42-207.98 tcf of gas. Table 4-4 presents projections of the major activities and impact-producing factors related to future OCS Program activities.

Western Planning Area: Estimates of total reserve/resource production related to the proposed actions in the WPA plus prior and future sales (OCS Program) in the WPA over the 40-year analysis period are 3.35-5.53 BBO and 42.66-58.17 tcf of gas. This represents approximately 22-25 percent of the oil and 28 percent of the gas of the total OCS Program. Table 4-5 presents projections of the major activities and impact-producing factors related to future operations in the WPA.

Central Planning Area: Estimates of total reserve/resource production related to the proposed actions in the CPA plus prior and future sales (OCS Program) in the CPA over the 40-year analysis period are 12.00-16.52 BBO and 108.27-146.27 tcf of gas. This represents approximately 74-78 percent of the oil and 70 percent of the gas of the total OCS Program. Table 4-6 presents projections of the major activities and impact-producing factors related to future operations in the CPA.

Eastern Planning Area: Projected production for the OCS Program in the EPA represents anticipated production from lands currently under lease in the EPA, plus anticipated production from future EPA sales over the 40-year analysis period. The projected production for the OCS Program in the EPA assumes future leasing only in the Revised Proposal Lease Sale 181 area. The reader should be aware that the moratoria on leasing in the EPA may be lifted or reconfigured at some future time and leasing could occur in a larger area, which would change the projections for the cumulative OCS Program in the EPA.

Estimates of total reserve/resource production related to prior and future sales (OCS Program) in the EPA over the 40-year analysis period are 0.14-0.37 BBO and 2.49-3.54 tcf of gas. This represents 1-2 percent of the oil and approximately 2 percent of the gas of the total OCS Program. Table 4-7 presents projections of the major activities and impact-producing factors related to future operations in the EPA.

4.1.1.2. Exploration

4.1.1.2.1. Seismic Surveying Operations

Geophysical seismic surveys are performed to obtain information on surface and near-surface geology and on subsurface geologic formations. The MMS has almost completed a programmatic environmental assessment (EA) on geological and geophysical (G&G) permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies and operations; this information was used in the preparation of this EIS and is incorporated here by reference and is summarized below. High-resolution surveys done in support of lease operations are authorized under the lease. Most other seismic surveys are authorized under G&G permits.

High-resolution seismic surveys collect data on surficial geology used to identify potential shallow geologic hazards for engineering and site planning for bottom-founded structures. They are also used to identify environmental resources such as chemosynthetic community habitat. Deep-penetration, common-depth-point (CDP) seismic surveys obtain data about geologic formations greater than 10,000 m below the seafloor. High-energy, marine seismic surveys include both two-dimensional (2D) and three-dimensional (3D) surveys. Data from 2D/3D surveys are used to map structure features of stratigraphically important horizons in order to identify potential hydrocarbon traps. They can also be used to identify and map habitats for chemosynthetic communities.

Typical seismic surveying operations tow an array of airguns (the seismic sound source) and a streamer (signal receiver cable) behind the vessel 5-10 m below the sea surface. The airgun array produces a burst of underwater sound by releasing compressed air into the water column, which creates an acoustical energy pulse. The release of compressed air every several seconds creates a regular series of strong acoustic impulses separated by silent periods lasting 7-16 seconds, depending on survey type and depth to the target formations. Airgun arrays are designed to focus the sound energy downward. Acoustic (sound) signals are reflected off the subsurface sedimentary layers and recorded near the water surface by hydrophones spaced within streamer cables. These streamer cables are often 3 mi or greater in length. Vessel speed is typically 4.5-6 knots (about 4-8 mph) with gear deployed.

The 3D seismic surveying enables a more accurate assessment of potential hydrocarbon reservoirs to optimally locate exploration and development wells and minimize the number of wells required to develop a field. State-of-the-art interactive computer mapping systems can handle much denser data coverage than the older 2D seismic surveys. Multiple-source and multiple-streamer technologies are used for 3D seismic surveys. A typical 3D survey might employ a dual array of 18 guns per array. Each array might emit a 3,000-in^3 burst of compressed air at 2,000 pounds per square inch (psi), generating approximately 4,500 kilojoule (kJ) of acoustic energy for each burst. At 10 m from the source, the pressure experienced is approximately ambient pressure plus 1 atmosphere (atm). The streamer array might consist of 6-8 parallel cables, each 6,000-8,000 m long, spaced 75 m apart. A series of 3D surveys collected over time (four-dimensional or 4D seismic surveying) is used for reservoir monitoring and management (the movement of oil, gas, and water in reservoirs can be observed over time).

Prior to 1989, explosives (dynamite) were used in certain limited areas to generate seismic pulses. Explosives have been replaced by piston-type acoustic sources that generate superior acoustic signals and that do not cause the damaging environmental impacts associated with explosives. Rapid rise time (high velocity), high peak pressure, and rapid energy decrease characterize acoustical energy from explosives. Seismic airguns are considered nonexplosive and have long rise times to peak pressure (low velocity). It is assumed that no explosives will be used in future seismic surveys.

Multicomponent data, sometimes referred to as 4C data, is a product of an emerging technology that incorporates recording the traditional seismic compressional (P) waves with a full complement of other wave types, but predominantly shear (S) waves. The 4C technology provides a second independent image of a geologic section as well as improves the lithology picture in structurally complex areas. It can also aid in reservoir fluid prediction. The 4C data may be 2D or 3D in nature and procedurally involves draped or towed ocean-bottom receiver cable(s) for acquisition. The 4C data can be used as a defining prelease tool or a postlease aid for reservoir prediction.

The number of prelease geophysical permits in the Gulf has been consistently high over the last five years. The MMS anticipates an increase in the number of permit applications Gulfwide, due in part to an increase of high-resolution data applications, as well as additional 2D-4C and 3D-4C multicomponent applications for operations mostly located in mature areas on the shelf. In addition, extensive 2D surveys with deep-penetration capabilities are being run in areas where limited or dated seismic coverage presently exist. State-of-the-art 3D seismic data have enabled industry to identify, with greater precision, where the most promising deepwater prospects are located.

Postlease seismic surveying may include high-resolution, 2D, 3D, or 4D (4D is a series of 3D surveys collected over time) surveying. In addition, multicomponent data (2D-4C and 3D-4C data) may be collected to improve lithology and reservoir prediction. High-resolution surveying is done on a site-specific or lease-specific basis or along a proposed pipeline route. These surveys are used to identify potential shallow, geologic hazards for engineering and site planning for bottom-founded structures. They are also used to identify environmental resources such as hard-bottom areas, topographic features, potential chemosynthetic community habitat, or historical archaeological resources. New technology has allowed for 3D acquisition and for deeper focusing of high-resolution data. Postlease, high-resolution seismic surveying is assumed to be done once for each lease.

Deeper penetration seismic surveying (2D, 3D, or 4D) may also be done postlease for more accurate identification of potential reservoirs, increasing success rates for exploratory drilling and aiding in the identification of additional reservoirs in "known" fields. This 3D technology can be used in developed areas to identify bypassed hydrocarbon-bearing zones in currently producing formations and new productive horizons near or below currently producing formations. It can also be used in developed areas for reservoir monitoring and field management. The 4D seismic surveying is used for reservoir monitoring and management, as well as in identifying bypassed "pay zones." Through time-lapsed surveys, the movement of oil, gas, and water in reservoirs can be observed over time. Postlease, deep seismic surveys may occur periodically throughout the productive life of a lease.

Developing technologies that may provide additional detail on the geology and fluids beneath the seafloor might be appropriate for use in the deepwater areas of the Gulf. These technologies include vertical cables, marine vibrators, and combinations of multiple vessels, source arrays, and streamers.

4.1.1.2.2. Exploration and Delineation Drilling Plans

Operators use drilling terms that represent stages in the discovery and exploitation of hydrocarbon resources. An exploration well generally refers to the first well drilled on a prospective structure to determine if a resource exists. If a resource is discovered, a delineation well is a follow-up well used to define the amount of resource or the extent of the reservoir.

In the Gulf of Mexico, exploration and delineation wells are typically drilled with mobile offshore drilling units (MODU's), e.g., jack-up, semisubmersible, or drillship. The type of rig chosen to drill a prospect depends primarily on water depth. Since the water depth ranges for each type of drilling rig overlap, other factors such as availability and daily rates are also considered when deciding upon the type of rig to use. The table below indicates the depth ranges used in this analysis for Gulf of Mexico MODU's.

MODU or Drilling Rig Type	Water-Depth Range
Jack-up	up to 100 m
Semisubmersible	100 to 600 m
Drillship	greater than 600 m

This scenario assumes that an average exploration/delineation well will require 30-45 days to drill. The actual time required for each well depends on a variety of factors including the depth of the prospect's potential target zone, complexity of the well design, and the directional offset of the well bore needed to reach a particular zone. This scenario assumes that the average exploration or delineation well depth will be 3,674 m (12,055 ft) below mudline.

Dual gradient drilling (DGD) is perhaps the greatest single technological advancement for drilling in deep water and ultra-deepwater environments (Figure 4-33). As drilling operations move into deeper waters, the hydrostatic pressure represented by the mud column in the riser introduces a major challenge for well control. In drilling young, rapidly subsiding depositional basins typical of the Gulf of Mexico, the margin between high-formation pore pressures and low-fracture resistance pressures require additional casing strings in both the upper part of the hole and in pressure transition zones. At issue is that slightly overweighted mud can be quickly lost to the formation because the difference in pressure between keeping the well and formation pressure in balance with the mud and fracking the formation is very small. With extra casing strings in the shallow part of the well, the bottom-hole casing size can be as small as 6-6.75 in - too small to permit horizontal or multilateral completions. The cost of an ultra-deepwater (>6,000 ft water depth) well can be $30-50 million or more, without certainty that objectives can be reached. The solution to the problem of narrow margins between formation pore pressure and fracture resistance is DGD.

Unlike conventional single gradient drilling technology, in which control of bottom-hole pressure is achieved with a mud column from the bottom of the well back to the rig, DGD achieves the same effect by using drilling mud from the hole bottom to the mudline, and seawater in the riser from the mudline to the surface rig floor; the result is a DGD system. Subsea pumps separate formation water or hydrocarbon from drilling fluid and cuttings and circulate it back to the surface in separate lines. Seawater replaces mud in the marine riser that connects the wellhead to the surface rig. The basic goal of DGD is to create a situation where the well perceives that only the weight of seawater exists above the mudline so that the formation below the mudline reacts as though the rig is sitting on the seafloor and the problem of hydrostatic pressure is eliminated. Not only does this method eliminate as many as four strings of casing, but it is possible to drill in almost any water depth and reach the well's objectives with a bottom-hole diameter of about 12 in. This diameter is large enough to permit 7-in production casing to be installed up to the mudline and provide for both horizontal and multilateral completions. Operators estimate that DGD systems can save $5-15 million on a deepwater well.

The MMS mandates that operators conduct their offshore operations in a safe manner. Subpart D of the MMS's operating regulations (30 CFR 250) provides guidance to operators on drilling activities. For example, operators are required by 30 CFR 250.400 to take necessary precautions to keep their wells under control at all times using the best available and safest drilling technology (NTL 99-G01). Deepwater areas pose some unique concerns regarding well control activities. In 1998, the International Association of Drilling Contractor (IADC) published deepwater well control guidelines (IADC, 1998) to assist operators in this requirement. These guidelines address well planning, well control procedures, equipment, emergency response, and training.

As drilling activities occur in progressively deeper waters, operators may consider using MODU’s that have onboard hydrocarbon storage capabilities. This option may be exercised if a well requires extended flow testing, 1-2 weeks or longer, in order to fully evaluate potential producible zones and to justify the higher costs of deepwater development activities. The liquid hydrocarbons resulting from an extended well test could be stored and later transported to shore for processing. Operators may also consider barging hydrocarbons from test wells to shore. There are some dangers inherit with barging operations if adverse weather conditions develop during testing. If operators do not choose to store produced liquid hydrocarbons during the well testing, they must request and receive approval from the MMS to burn test hydrocarbons.

Drilling Rig Availability: The average number of rigs drilling in the deep waters (waters depths of 305 m or greater) in the Gulf of Mexico jumped dramatically between 1992 and 1999, from 3 to 27 rigs (Baud et al., 2000). Competition for deepwater drilling rigs in the GOM may limit the availability of these MODU’s to drill deepwater prospectsDrilling activities may also be constrained by the availability of both rig crews, risers, and other equipment.

CPA Proposed Action Scenario: It is estimated that 111-247 exploration and delineation wells will be drilled as a result of a proposed action in the CPA. Table 4-2 shows the estimated range of exploration and delineation wells by water depth subarea. Approximately 64 percent of the projected wells are expected to be on the continental shelf (0-200 m water depth) and about 25 percent are expected in the intermediate water-depth range (200-1,600 m). Exploratory drilling activities in support of a proposed action in the CPA are projected to increase for the first nine years following a proposed sale, reach its peak in year nine, and begin a steady decline through the 40-year analysis period.

WPA Proposed Action Scenario: It is estimated that 37-115 exploration and delineation wells will be drilled as a result of a proposed action in the WPA. Table 4-3 shows the estimated range of exploration and delineation wells by water depth subarea. Approximately 46 percent of the projected wells are expected to be on the continental shelf (0-200 m water depth) and slightly over 39 percent are expected in the intermediate water-depth range (200-1,600 m). Exploratory drilling activities in support of a proposed action in the WPA are projected to increase for the first six years following a proposed sale, then drilling intensity is projected to dramatically drop off.

OCS Program Scenario: It is estimated that 8,996-11,333 exploration and delineation wells will be drilled Gulfwide as a result of the OCS Program. Table 4-4 shows the estimated range of exploration and delineation wells by water depth subarea. Of these wells 76-79 percent will be in the CPA and 20-24 percent will be in the WPA. Activity is projected to be relatively stable for the first 10 years of the analysis period, and then a steady reduction in the annual rate of exploration and delineation wells to 50 percent.

4.1.1.3. Development and Production

4.1.1.3.1. Development and Production Drilling

A production well is drilled to exploit the unique configuration of a discovered or known hydrocarbon field. Delineation or production wells can collectively be termed development wells. Development or production wells may be drilled from movable structures, such as jack-up rigs fixed bottom-supported structures, floating vertically moored structures, floating production facilities (often called semisubmersibles), and drillships (dynamically positioned drilling vessels). The spectrum of these production systems are shown in Figure 4-2.

The type of production structure installed at a site depends mainly on water depth. The number of wells per structure varies according to the type of production structure used, the prospect size, and the drilling/production strategy deployed for the drilling program and for resource conservation. Systems used to produce hydrocarbons can be fixed, floating, or increasingly in deep water subsea. Advances in the composition of drilling fluids and dual-density drilling technology are likely to provide operators with the means to reduce rig costs in the deepwater OCS program.

Types of Production Structures: The MMS has described and characterized production structures in its deepwater reference document (Regg et al., 2000). These descriptions were used in preparing the scenario for this EIS. In water depths of up to 400 m, the scenario assumes that conventional, fixed platforms that are rigidly attached to the seafloor will be the type of structure preferred by operators. In water depths of less than 200 m, 20 percent of the platforms are expected to be manned (defined as having sleeping quarters on the structure). In depths between 200 and 400 m, all structures are assumed to be manned. It is also assumed that helipads will be located on 66 percent of the structures in water depths less than 60 m, on 94 percent of structures in water depths between 60 and 200 m, and on 100 percent of the structures in water depths greater than 200 m. At water depths exceeding 400 m, platform designs based on rigid attachment to the seafloor are not expected to be used. The 400-m isobath appears to be the current economic limit for this type of structure.

Fixed: A fixed platform (Figure 4-2) consists of a jacket (a vertical section made of tubular steel members supported by piles driven into the seafloor) with a deck section to provide space for crew quarters, a drilling rig, other equipment, storage, and production and support facilities.

A compliant tower consists of a piled foundation that usually supports a narrow, tubular steel trellis-type tower. The structure is kept on station by guyed wires anchored to the seabed or stressed members within the tower. A conventional deck sits on top of the tower for drilling, workover, and production operations. Compliant towers may be used in water depths between 300 and 900 m.

Floating: A tension-leg platform (TLP) consists of a floating structure or hull held in place by tensioned tendons connected to a foundation on the seafloor that is secured by piles that are driven into the seabed. The tensioned tendons provide a broad depth range of utilization and also limit the TLP's vertical motion and, to a degree, its horizontal motion. At present, TLP's can be used in water depths up to approximately 2,100 m. Mini-TLP's may be used to develop smaller deepwater reservoirs when economics dictate. Mini-TLP's may also be used as utility, satellite, or early production structures for larger deepwater discoveries. Operators may consider using mini-TLP's for prospects in water depths from l80 to 1,100 m.

A spar structure is a deep-draft, floating caisson that may consist of a large-diameter (27.4 to 36.6 m) cylinder or a cylinder with a lower tubular steel trellis-type component (truss spar) that supports a conventional production deck. The cylinder or hull may be moored via a chain catenary or semi-taut line system connected to 6-20 anchors on the seafloor. Spars are now used in water depths up to 900 m and may be used in water depths as great as 3,000 m.

Semisubmersible production structures resemble their drilling rig counterparts. Their hull contains pontoons below the waterline and vertical columns to the hull box/deck. The structures keep on station with conventional catenary or semi-taut line mooring systems connected to anchors in the seabed. Semisubmersibles may be used in similar water depths as spars (3,000 m or deeper).

The MMS has prepared an EIS on the potential use of floating production, storage, and offloading (FPSO) systems on the Gulf of Mexico OCS (USDOI, MMS, 2001a). In accordance with the scenario provided by industry, the FPSO EIS addresses the proposed use of FPSO's in the deepwater areas of the WPA and CPA only. At this time, industry has not submitted a development plan indicating that an FPSO will be used for development. However, the cumulative scenarios project possible FPSO usage in either the WPA or CPA. A new and evolving technology for deepwater development involves the use of minimal floating structures. These buoy-like structures allow the placement of minimal equipment at the surface. They have the advantages of relatively low cost and surface access to the well(s). These structures are dependent on "host" facilities for control and for final processing of the produced hydrocarbons.

Subsea: For some development programs, especially those in deep water, an operator may chose to use a subsea production system instead of a floating production structure. A subsea production system comprises various components including templates, production tree (well head), "jumper" pipe connections, manifolds, pipelines, control equipment, and umbilicals. A subsea production system can range from a single-well template with production going to a nearby structure to multiple-well templates producing through a manifold to a pipeline and then to a riser system at a distant production facility, possibly in shallower waters.

Subsea systems rely on a "host" facility for support and well control. Centralized or "host" production facilities in deep water or on the shelf may support several satellite subsea developments. Unlike wells from conventional fixed structures, subsea wells do not have surface facilities directly supporting them during their production phases. A drilling rig must be brought on location to provide surface support to reenter a well for workovers and other types of well maintenance activities. In addition, should the production safety system fail and a blowout result, surface support must be brought on location to regain well control.

Although the use of subsea systems has recently increased as development has moved into deeper water, subsea systems are not new to the Gulf and subsea systems are not used exclusively for deepwater development. The first subsea wells in the Gulf were installed in 1964. Subsea systems in the Gulf are currently used in water depths up to 1,615 m. Operators are contemplating their use out to 3,000 m and beyond.

Emerging Technologies: Technological advancements in the oil and gas industry have not only improved the discovery and recovery of hydrocarbons on the OCS, but they have lessened impacts on the environment. For example, extended-reach well drilling, horizontal well bores and completions, electronic safety systems, dual gradient drilling, and synthetic drilling fluids are technologies that accomplished both goals. Extended-reach technology (specialized directional drilling) allows wells to be drilled as far as 6-8 km (4-5 mi) from a centralized surface location. The advantage to the environment from this technology comes from reducing the number of structures needed to develop a field. Horizontal drilling allows a well bore to intersect more of the producing formation than is possible with conventionally drilled holes. Increased production can be realized from these horizontally drilled wells. This technology allows more reserves to be produced from a single wellbore. Ultimately, fewer wells may be drilled to recover equal quantities of hydrocarbons from a particular zone. Electronic safety systems are used to monitor safety functions including shutdowns, alarms, and other critical devices. These systems are more reliable and accurate than previously used safety systems, allowing operators to respond more quickly to potential problems.

Dual gradient drilling (DGD) is an emerging technology that may revolutionize drilling operations in the deeper areas of the Gulf of Mexico. The industry is currently drilling its first well using this technology in Green Canyon, Block 136. A series of papers presented at the 2001 Society of Petroleum Engineers conference in New Orleans describe this joint industry project (Smith et al., 2001; Schumacher et al., 2001; and Eggemeyer et al., 2001). The DGD technology is similar to single gradient drilling procedures in that it provides the appropriate amount of hydrostatic bottom-hole pressure to maintain well control. The DGD system differs from conventional drilling procedures by using two fluids instead of one fluid in the well to accomplish this requirement. Under conventional drilling technology, a single mud weight is used from the surface facilities on the drilling rig to the well's total depth. The DGD system has drilling fluid from the seafloor mudline to the well's total depth but uses another fluid such as treated seawater from the mudline back up to the rig's floor. Specialized equipment, including subsea mud pumps, is used to circulate drilling fluid and cuttings to the surface under DGD operations. Using the DGD system, the margins between fracture gradient and pore pressure are significantly greater than under conventional single gradient drilling procedures. Operators believe that DGD wells may be drilled at lower costs with more safety and more completion flexibility than under single gradient drilling procedures.

The MMS prepared Site-specific Environmental Assessments (S-5409 and S-5499) for the test well. The MMS determined that the potential environmental effects from the use of the DGD technology were comparable to, or better than, those expected from more conventional technology (30 CFR 250.141) (USDOI, MMS, 2000b; SEA S-5409).

Synthetic drilling fluids (SDF) have also had a significant effect on exploration and development operations. A recent Department of Energy publication (USDOE, 1999) cites results from a Gulf of Mexico operator study that concluded that SDF significantly outperformed water-based fluids (WBF). Of eight wells drilled under comparable conditions to the same depth, the study found that the three wells drilled using SDF were completed in an average of 53 days at a cost of approximately $5.5 million. In comparison, the five wells drilled using WBF were completed in an average of 195 days at a cost of approximately $12.4 million. The environmental benefits from the use of SDF include reduced air emissions because of shorter drilling times and less waste because SDF are reconditioned and recycled.

CPA Proposed Action Scenario: It is estimated that 178-352 development will be drilled as a result of a proposed action in the CPA. Table 4-2 shows the estimated range of development wells by water-depth subarea. Approximately 50 percent of the projected wells are expected to be on the continental shelf (0-200 m water depth) and about 33 percent are expected in the intermediate water-depth range (200-1,600 m). For gas development wells, approximately 68 percent of those projected are on the continental shelf (0-200 m water depth) and about 23 percent are in the intermediate water-depth range (200-1,600 m). For oil development wells, approximately 31 percent are on the continental shelf (0-200 m water depth) and about 44 percent are in the intermediate water-depth range (200-1,600 m). Drilling is projected to steadily increase for the first 10 years, then hit a plateau for the next 12 years, and start an almost linear decline.

WPA Proposed Action Scenario: It is estimated that 97-166 development will be drilled as a result of a proposed action in the CPA. Table 4-3 shows the estimated range of development wells by water-depth subarea. Approximately 37 percent of the projected wells are expected to be on the continental shelf (0-200 m water depth) and about 47 percent are expected in the intermediate water-depth range (200-1,600 m). Trends between the oil and gas development wells are markedly different. For oil wells, the intermediate water-depth range (200-1,600 m) constitutes the largest portion of oil wells, over 59 percent. For gas wells, the continental shelf (0-200 m water depth) had the greatest concentration of projected gas wells, about 58 percent. Drilling is projected to steadily increases to a plateau peak about year 9 through year 19. Then, a steady decrease in activity is projected.

OCS Program Scenario: It is estimated that 17,148-21,079 development wells will be drilled Gulfwide as a result of the OCS Program. Table 4-4 shows the estimated range of development wells by water depth. In the CPA, development activities start at a relatively high rate (about 450 wells per year) and remain around that level for approximately 13 years. Activities then begin to decline fairly steadily until the end of the scenario. In the WPA, development activities are projected to steadily increase for the scenario's first 14 years, level off for approximately 9 or 10 years, and then begin to decline.

4.1.1.3.2. Infrastructure Emplacement/Structure Installation and Commissioning Activities

Bottom-founded or floating structures may be placed over development wells to facilitate production from a prospect. They provide protection for and control of the wells. They also serve as a platform to conduct additional drilling and workover activities, to process and treat produced fluids from the wells, and to initiate export of the produced hydrocarbons.

Structure installation and commissioning activities may take place over a period of a week to a month at the beginning of a platform’s 20- to 40-year production life. Derrick barges may be used to upright and position structures. Usually moorings and anchors are attached to keep the structure on station. Commissioning activities involve all of the interconnecting and testing of the structure's modular components.

CPA Proposed Action Scenario: Table 4-2 shows the projected number of structure installations for a proposed action in the CPA by water-depth range. About 81 percent of all the production structure installation projected for a proposed action in the CPA are on the continental shelf (0-200 m). Approximately 12 percent of the structures are projected for the 200-1,600 m water-depth range.

WPA Proposed Action Scenario: Table 4-3 shows the projected number of structure installations for a proposed action in the WPA by water-depth range. About 65 percent of all the production structure installation projected for a proposed action in the WPA are slated for the traditional shelf (0-200 m). Approximately 19 percent of the structures are projected for the 200-1,600 m water-depth range.

OCS Program Scenario: Table 4-4 shows the projected number of structure installations by water-depth range for the Gulfwide OCS Program. In the WPA, about 84 percent of all the production structure installations projected for the WPA are estimated for the continental shelf (0-200 m) and 13 percent in 200-1,600 m water depths. In the CPA, more than 90 percent of all the production structure installations projected for the CPA are estimated for the continental shelf (0-200 m).

4.1.1.3.2.1. Bottom Area Disturbance

Structures emplaced or anchored on the OCS to facilitate oil and gas exploration, development, and production include drilling rigs (jack-ups, semisubmersibles, and drillships), production platforms, subsea systems, and pipelines. The emplacement of these structures disturbs some area of the sea bottom beneath the structure. If anchors are employed, there are some areas around the structure that are also disturbed. This disturbance includes both physical compaction beneath the structure and the resuspension and settlement of sediments. Jack-up rigs and semisubmersibles are assumed to be used in water depths less than 750 m and to disturb about 1.5 ha (3.7 ac) each. In water depths greater than 750 m, dynamically positioned drillships will be used, disturbing no bottom area (except a very small area where the well is drilled). Conventional, fixed platforms installed in water depths less than about 400 m disturb about 2 ha. At water depths exceeding 400 m, compliant towers, tension-leg platforms (TLP's), spars, and floating production systems (FPS's) will be used (Figure 4-2). A compliant tower consists of a narrow flexible tower and a piled formation that supports a conventional deck. A compliant tower would disturb the same bottom area—about 2 ha—as a conventional, fixed platform. A TLP consists of a floating structure held in place by tensioned tendons connected to the seafloor by templates secured with piles. A TLP would disturb about 5 ha of bottom area. A spar platform consists of a large-diameter cylinder supporting a conventional deck, three types of risers (production, drilling, and export), and a hull that is moored via a taut catenary system of 6-20 lines anchored to the seafloor. The bottom area disturbed by a spar is dependent on the anchor configuration and would be about 5 ha. A FPS consists of a semisubmersible vessel anchored in place with wire rope and chain. A FPS would disturb about 1.5 ha of sea bottom. Subsea systems, located on the ocean floor, are connected to the surface deck via production risers and would disturb less than 1 ha each. Emplacement of pipelines disturbs about 0.32 ha of seafloor per kilometer of pipeline.

Impacts from bottom disturbance are of concern near sensitive areas such as topographic features, pinnacles, low-relief live-bottom features, chemosynthetic communities, high-density biological communities in water 400 m or greater, and archaeological sites. Regulations and mitigating measures protect these sensitive areas from potential impacts resulting from bottom disturbance.

4.1.1.3.2.2. Sediment Displacement

Trenching for pipeline burial causes displacement or resuspension of seafloor sediments. The MMS's regulations (30 CFR 250.1003(a)(1)) require that pipelines installed in water depths <61 m (<200 ft) are buried to a depth of at least 3 ft below the mudline. Burying is required to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, to reduce the risk of fishing gear becoming snagged, and to minimize interference with the operations of other users of the OCS. It is assumed that 5,000 m^3 of sediment will be resuspended for each kilometer of pipeline trenched.

Sediment displacement also occurs as a result of the removal of pipelines. It is projected that the number of pipeline removals (or relocations) will increase Gulfwide as the existing pipeline infrastructure ages. For each kilometer of pipeline removed in water depths less than 61 m, approximately 5,000 m^3 of sediment would be resuspended.

Displaced sediments are those that have been physically moved "in bulk." Displaced sediments will cover or bury an area of the seafloor, while resuspended sediments will cause an increase in turbidity of the adjacent water-column. Resuspended sediments eventually settle, covering the surrounding seafloor. Resuspended sediments may include entrained heavy metals or hydrocarbons.

4.1.1.3.3. Infrastructure Presence

4.1.1.3.3.1. Anchoring

Most exploration drilling, production platform, and pipeline emplacement operations on the OCS require anchors to hold the rig, structure, or support vessels in place. These anchors disturb the seafloor and sediments of the area. Anchoring can cause physical compaction beneath the anchor and associated chains or lines, and the resuspension and settlement of sediments.

Conventional pipelaying barges use an array of eight 9,000-kg anchors to position the barge and to move it forward along the pipeline route. These anchors are continually moved as the pipelaying operation proceeds. The area actually affected by these anchors depends on water depth, wind, currents, chain length, and the size of the anchor and chain. Dynamically positioned pipelaying barges do not anchor.

Mooring buoys may be placed near drilling rigs or platforms so that service vessels need not anchor, especially in deeper water. These temporarily installed anchors will most likely be smaller and lighter than those used for vessel anchoring and, thus, will have less impact on the sea bottom. Moreover, installing one buoy will preclude the need for numerous individual vessel-anchoring incidents. Service-vessel anchoring is assumed to not occur in water depths greater than 150 m and only occasionally in shallower waters (vessels would always tie up to a platform or buoy in water depths > 150 m).

Barges are assumed to always tie up to a production system rather than anchor. Barges and other vessels are also used for both installing and removing structures. These vessels use anchors placed away from their location of work. Drillships use dynamic positioning systems to remain in place and do not anchor.

4.1.1.3.3.2. Space-Use Conflicts

During OCS operations, the areas occupied by seismic vessels, structures, anchor cables, and safety zones are unavailable to commercial fishermen. Seismic surveys will occur in both shallow and deepwater areas of the proposed actions. Usually, fishermen are precluded from a very small area for several days during active seismic surveying. Exploratory drilling rigs spend approximately 40-150 days on-site and are a short-term interference to commercial fishing. A major bottom-founded production platform in water depths less than 450 m, with a surrounding 100-m navigational safety zone, requires approximately 6 ha of space. A bunkhouse structure requires about 4 ha and a satellite structure requires about 1.5 ha of space. Virtually all commercial trawl fishing in the Gulf of Mexico is performed in water depths less than 200 m (Louisiana Dept. of Wildlife and Fisheries, 1992). A total of 31.2 million ha in the Central and Western Gulf is located in water depths of 200 m or less.

Longline fishing is performed in water depths greater than 100 m and usually beyond 300 m. All surface longlining is prohibited in the northern DeSoto Canyon area (designated as a swordfish nursery area by the National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries), formerly known as the National Marine Fisheries Service (NMFS)). The longline closure area encompasses at least some part of 173 blocks in the CPA. In the EPA, the closure area encompasses 160 blocks within the Revised Proposal Lease Sale 181 area. Longline fishing will also probably be precluded from blocks for miles around the closure area because of the great length of typical longline sets and time required for their retrieval.

In water depths greater than 450 m, production platforms will be compliant or floating structures (such as TLP's and spar's) (Figure 4-2); this is beyond the range of typical commercial trawling. Even though production structures in deeper water are larger and individually will take up more space, there will be fewer of them compared to the great numbers of bottom-founded platforms in shallower water depths. The use of tanker-based FPSO's is also being considered by operators in the Gulf. The U.S. Coast Guard (USCG) has not yet determined what size navigational safety zone will be required during offloading operations. Factoring in various configurations of navigational safety zones, other deepwater facilities may require up to a 500-m-radius safety zone or 79 ha of space (USCG regulations, 33 CFR Chapter 1, Part 147.15). Production structures in all water depths have a life expectancy of 20-30 years. The MMS data indicate that the total area lost to commercial fishing due to the presence of production platforms has historically been and will continue to be less than 1 percent of the total area available.

Proposed Action Scenario: A maximum of 102 ha (17 structures @ 6 ha) will be lost to commercial fishing as a result of a proposed action in the WPA and 300 ha (50 structures @ 6 ha) for a proposed action in the CPA. This is approximately 0.001 percent of the total area available in the sale areas. Considering that virtually all trawling occurs in water depths of less than 200 m, the maximum area lost to trawling is about 22 percent less than the total unavailable area (15 of the 67 total structures projected for the proposed actions are in water depths greater than 200 m).

OCS Program Scenario: Total OCS production structure installation Gulfwide has been estimated through the year 2042. The estimated number of platforms installed varies widely between water-depth subareas. In the WPA, production structure installation ranges from a low of 3-8 platforms in depths greater than 2,400 m to a high range of 428-628 in the shallowest water depth subarea (to a depth of 60 m). Projected CPA installations range from 9 to 23 in the deepwater (greater than 2,400 m) to a high of 1,810-2,441 structures in the shallowest water depth subarea (to a depth of 60 m). The total number of installations for the CPA ranges from 2,360 to 3,218 for all depth ranges. Total activity in the EPA is estimated to range from 4 to 7 installed production structures between 2003 and 2042.

As identified oil and gas fields are developed and fewer new reservoirs are located, the overall annual rate of platform and structure installation will decrease. Platform removal rates are expected to increase as mature fields are depleted. The rate of platform removal is projected to average between 130 and 180 structures per year. The trend of increased area lost to commercial fishing will be reversed over time as the rate of platform removals exceeds the rate of platform installation. It is assumed that the total area lost to commercial fishing due to the presence of OCS production platforms will continue to be less than 0.1 percent of the total area available to commercial fishing.

4.1.1.3.3.3. Aesthetic Interference

The factors that could adversely affect the aesthetics of the coastline are oil spills and residue, tarballs, trash and debris, noise, pollution, increased vessel and air traffic, and the presence of drilling and production platforms visible from land. Oil spills, oil residue from tankers cleaning their holding tanks, and tarballs could affect the beauty of beaches, wetlands, and coastal residences. Increased vessel and air traffic may result in additional noise, or in oil and chemical pollution of water in port and out to sea. The potential visibility of fixed structures in local Gulf waters is worrisome for local chambers of commerce and tourist organizations. In a study conducted by the Geological Survey of Alabama (GSA) in 1998, several facets of the visibility of offshore structures were analyzed. The GSA earth scientists found that visibility is dictated not only by size and location of the structures and curvature of the Earth, but also by atmospheric conditions. Social scientists added factors, such as the viewer's elevation—ground level, in a two-story house, or in a 30-story condominium—and the viewer's expectations and perceptions. The size of an offshore structure depends on the reservoir being tapped, characteristics of the well-stream fluid, and the type of processing needed to treat the hydrocarbons. Location reflects the geology of the reservoir being exploited. Optimal location of structures means at or near the surface of the reservoir (GSA, 1998). Atmosphere refers to conditions of weather, air quality, and the presence or absence of fog, rain, smog, and/or winds. The height of the viewer affects their ability to see and distinguish objects several yards or miles away. Perceptions often dictate what people expect to see and, hence, what they do see.

To test visibility in as scientific a way as possible, GSA staff worked with members of the Offshore Operators Committee. They took a series of photographs on one day in October 1997, from a helicopter hovering at 300 ft. They used the same camera, lens, shutter speed, and f-stop setting. The subjects of the photos were four different types of structures usually found in both State and Federal waters offshore Alabama. The structures ranged in height from 60 to 70 ft; they varied in size from 120 ft by 205 ft to 40 ft by 90 ft with the smallest being 50 ft by 80 ft. The tallest and widest structures, i.e., those showing the most surface in the viewscape, were visible at up to 5 mi from shore. The shorter and the smaller the structure, the less visible at 5 mi; the smallest could barely be seen at 3 mi from shore. According to this study, no structure located more than 10 mi offshore would be visible (GSA, 1999).

Additional impact-producing factors associated with offshore oil and gas exploitation are oil spills, and trash and debris. These are the most widely recognized as major threats to the aesthetics of coastal lands, especially recreational beaches. These factors, individually or collectively, may adversely affect the fishing industry, resort use, and the number and value of recreational beach visits. The effects of an oil spill on the aesthetics of the coastline depends on factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods (if any).

4.1.1.3.4. Operational Waste Discharged Offshore

The primary operational waste discharges generated during offshore oil and gas exploration and development are drilling fluids, drill cuttings, produced water, deck drainage, sanitary wastes, and domestic wastes. During production activities, additional waste streams include produced sand and well treatment, workover, and completion (TWC) fluids. Minor additional discharges occur from numerous sources; these discharges may include desalination unit discharges, blowout preventer fluids, boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater.

The USEPA, through general permits issued by the USEPA Region that has jurisdictional oversight, regulates all waste streams generated from offshore oil and gas activities. The USEPA published the most recent effluent guidelines for the oil and gas extraction point-source category in 1993 (58 FR 12454). The USEPA Region 4 has jurisdiction over the eastern portion of the Gulf of Mexico OCS including all of the EPA and the CPA off the coasts of Alabama and Mississippi. The USEPA Region 6 has jurisdiction over the rest of the CPA and all of the WPA. Each Region has promulgated general permits for discharges that incorporate the 1993 effluent guidelines as a minimum. The current Region 4 general permit was issued on October 16, 1998 (63 FR 55718), was modified on March 14, 2001 (66 FR 14988), and expires on October 31, 2003. The Region 6 general permit was issued on November 2, 1998 (63 FR 58722), was modified on April 19, 1999 (64 FR 19156), and expires on November 3, 2003. The USEPA also published new guidelines for the discharge of SBF on January 22, 2001 (66 FR 6850). On December 18, 2001, Region 6 published a notice of revision to the general permit, which became effective on February 16, 2002. The revision authorizes the discharge of drill cuttings produced using SBF and other nonaqueous-based drilling fluids and wastewater used to pressure test existing piping and pipelines. Region 4 has not revised the general permit to incorporate the new guidelines for SBF and other nonaqueous-based drilling fluids.

4.1.1.3.4.1. Drilling Muds and Cuttings

The largest discharges from drilling operations are drilling fluids (also known as drilling muds) and cuttings. Drilling fluids are used in rotary drilling to remove cuttings from beneath the bit, to control well pressure, to cool and lubricate the drill string, and to seal the well. Drill cuttings are the fragments of rock generated during drilling and carried to the surface with the drilling fluid.

The composition of drilling fluids is complex. The bulk of the mud consists of clays, barite, and a base fluid, which can be fresh or salt water; mineral or diesel oil; or any of a number of synthetic oils. Three categories of drilling fluids or muds are used on the OCS: water based, oil based, and synthetic based. Water-based drilling fluids (WBF) have been used for decades to aid drilling on the continental shelf. The WBF may have diesel oil or mineral oil added to them for lubricity. Occasionally, oil-based drilling fluids (OBF) are used for directional drilling and in sections where problems arise from using WBF. Since 1992, synthetic-based drilling fluids (SBF), have been increasingly used, especially in deepwater, because they perform better, are less toxic than OBF, and reduce drilling times, thus reducing the costs incurred from expensive drilling rigs. Most recently, internal olefins are the most prevalent base fluid for the SBF used in deepwater drilling in the Gulf of Mexico. However, some operators have used polyalpha olefins, esters, or their own proprietary blend as the base fluid. Numerous chemicals are added to improve the performance of the drilling fluid (Boehm et al., 2001).

The discharge of WBF and cuttings associated with WBF is allowed everywhere on the OCS under the general National Pollution Discharge Elimination System (NPDES) permits issued by Regions 4 and 6, as long as the discharge meets the toxicity guidelines. The USEPA (1993a and b) estimated that 12 percent of all drilling fluids and two percent of all drill cuttings were brought to shore for treatment and disposal under the previous NPDES general permit criteria. All OBF and associated cuttings must be transported to shore for recycling or disposal unless reinjected. For SBF, the discharge of the drilling muds is prohibited. Region 6 has allowed the discharge of cuttings wetted with SBF, while Region 4 does not. The current NPDES General Permits for OCS discharges in USEPA Region 4 (eastern CPA and EPA) and Region 6 (WPA and western CPA) will expire in October 2003 and April 2004, respectively.

In deeper water, the upper portion of the well, 1,000-1,500 m, is drilled with WBF and the remainder is drilled with SBF. The upper sections are drilled with a large diameter bit; progressively smaller drill bits are used with increasing depth. Therefore, the volume of cuttings per interval (length of wellbore) in the upper section of the well is greater than the volume generated in the deeper sections. Average values of muds and cuttings discharged during drilling are given in the Table 4-9. The estimated volume of SBF mud discharged is the amount of the base fluid adhering to cuttings and not a direct discharge of SBF, which is prohibited. The SBF is rented by the operator and at the end of drilling, the SBF is returned to the mud company for recycling. Since OBF's are used under special circumstances and may be replaced with SBF estimates of the amount of OBF muds and cuttings is not possible.

Drilling discharges of muds and cuttings are regulated by USEPA through an NPDES permit. Barite, barium sulfate, is a major component of all drilling fluid types (WBF, OBF, and SBF). Mercury and other trace metals are naturally occurring impurities in barite. Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 part per million (ppm) and 3 ppm, respectively, in the stock barite used to make drilling muds. Through mercury and cadmium regulation, USEPA can also control levels of other trace metals in barite. This reduces the addition of mercury to values similar to the concentration of mercury found in marine sediments throughout the GOM (Avanti Corporation, 1993a and b; USEPA, 1993a and b). Trace metals including mercury are of concern because of the potential for a toxic effect or bioaccumulation in some marine organisms. Mercury is of particular concern because it can be bioaccumulated in aquatic organisms. Concentrations of total mercury in uncontaminated estuarine and marine sediments generally are 0.2 μg/g dry weight or lower. Surface sediments collected 20-2,000 m away from four oil production platforms in the northwestern GOM contained 0.044-0.12 μg/g total mercury. These amounts are essentially background concentrations for mercury in surficial sediments on the GOM OCS (Neff, 2002).

Atmospheric mercury deposition is believed to be the main source of anthropogenic mercury inputs into the marine environment. Mercury in barite has been suggested as a secondary source in the GOM. Trace mercury in barite deposits is present predominantly as mercuric sulfate and mercuric sulfide (Trefry, 1998). Barite is nearly insoluble in seawater, thus trapping mercury and other trace metals in the barite grains. Therefore, unless the mercuric sulfide in the barite can be microbially methylated, this source of mercury is relatively unavailable for uptake into the marine food web. Research conducted by Neff et al. (1989) showed no uptake of mercury in winter flounder exposed to barite-amended sediments.

Inorganic mercury is converted to methylmercury in the environment. Methylmercury bioaccumulates through the food chain. It is bioaccumulated in the muscle of marine animals. Elevated levels of methylmercury have been found in top predatory fish and marine mammals (USEPA, 1997).

4.1.1.3.4.2. Produced Waters

Produced water is brought up from the hydrocarbon-bearing strata along with produced oil and gas. This waste stream can include formation water, injection water, and any chemicals (including well treatment, completion, and workover chemicals) added downhole or during the oil/water separation. Since the oil/water separation process does not completely separate the oil, some hydrocarbons remain with the produced water and often the water is treated to prevent the formation of sheen. The composition of the discharge can vary greatly in the amounts of organic and inorganic compounds.

The USEPA general permits allow the discharge of produced water on the OCS provided they meet discharge criteria. Oil and grease cannot exceed 42 milligrams per liter (mg/l) daily maximum or 29 mg/l monthly average. The Region 4 requires no discharge within 1,000 m of an area of biological concern. The discharge must also be tested for toxicity on a monthly basis.

Estimates of the volume of produced water generated per well are difficult because the percent water is a site-specific phenomenon. Usually, produced-water volumes are small during the initial production phase and increase as the formation approaches hydrocarbon depletion. Produced-water volumes range from 2 to 150,000 bbl/day (USEPA, 1993a and b). In some cases, a centralized platform is used to process water from several surrounding platforms. Some of the produced water may be reinjected into the well. Reinjection occurs when the produced water does not meet discharge criteria or when the water is used as part of operations.

The MMS maintains records of the volume of water produced from each block on the OCS. This information for the years 1996-2000 is summarized in the Table 4-10 and illustrated in Figure 4-3. The majority of blocks where water is produced are on the continental shelf off the coast of Louisiana. Very little water is produced off the coast of Texas because they are primarily gas fields.

Deepwater (>400 m water depth) production is fairly recent and very little water is produced at this time. For deepwater operations, new technologies are being developed that may discharge produced water at the seafloor or at "minimal surface structures" before the production stream is transported by pipeline to the host production facility.

4.1.1.3.4.3. Well Treatment, Workover, and Completion Fluids

Well treatment fluids are fluids that resurface from acidizing and/or hydraulic fracturing operations to improve hydrocarbon recovery. Production (well) treatment fluids consist of a wide variety of chemicals including corrosion and scale inhibitors, bactericides, paraffin solvents, demulsifiers, foamers, defoamers, and water treatment chemicals (Boehm et al., 2001). Some of the chemicals mix with the production stream and are transported to shore with the product. Other chemicals are discharged with the produced water. From 10 to 500 bbl per well treatment may be discharged as neutralized spent acid (USEPA, 1993a and b). In addition, most produced water cannot be discharged without some chemical treatment. Even water that is reinjected downhole must be cleaned to protect equipment.

Workover fluids and completion fluids are low solids fluids used to prepare a well for production, provide hydrostatic control, and/or prevent formation damage. Workover fluids include hydrochloric and other acids. Because of the corrosive nature of acids, particularly when hot, corrosion inhibitors are added. Since the fluids are altered, they cannot be recovered and recycled; however, these products may be mixed with the produced water and discharged overboard. The volume discharged can range from 100 to 1,000 bbl per job (USEPA, 1993a and b). Fluids used for completion consist of brines made from seawater mixed with calcium chloride, calcium bromide, and/or zinc bromide (Boehm et al., 2001). These salts can be adjusted to increase or decrease the density of the brine. Additives such as defoamers and corrosion inhibitors are used to reduce problems associated with the completion fluid. The recovered completion fluids are recycled for reuse.

The USEPA Region 4 and Region 6 general permits allow the discharge of well-treatment, workover, and completion (WTC) fluids, but the discharges must meet specified guidelines.

The discharge of free oil with the fluids is prohibited and must be monitored using the static sheen test. Oil and grease measurements must meet both a daily maximum of 42 mg/l and a monthly average of 29 mg/l. The discharge of priority pollutants is prohibited except in trace amounts. The fluids may be commingled and monitored with the produced water according to the Region 6 permit.

4.1.1.3.4.4. Production Solids and Equipment

As defined by USEPA in the discharge guidelines (58 FR 12454), produced sands are slurried particles, which surface from hydraulic fracturing, and the accumulated formation sands and other particles including scale generated during production. This waste stream also includes sludges generated in the produced-water treatment system, such as tank bottoms from oil/water separators and solids removed in filtration. The guidelines do not permit the discharge of produced sand, which must be transported to shore and disposed of as nonhazardous oil-field waste according to State regulations. Estimates of total produced sand expected from a platform are from 0 to 35 bbl/day according to USEPA (1993a and b).

A variety of solid wastes are generated including construction/demolition debris, garbage, and industrial solid waste. No equipment or solid waste may be disposed of in marine waters.

4.1.1.3.4.5. Deck Drainage

Deck drainage includes all wastewater resulting from platform washings, deck washings, rainwater, and runoff from curbs, gutters, and drains including drip pans and work areas. The USEPA general guidelines for deck drainage require that no free oil be discharged, as determined by visual sheen.

The quantities of deck drainage vary greatly depending on the size and location of the facility. An analysis of 950 Gulf of Mexico platforms during 1982-1983 determined that deck drainage averaged 50 bbl/day/platform (USEPA, 1993a and b). The deck drainage is collected, the oil is separated, and the water is discharged to the sea. Impacts from the discharge of deck drainage are assumed to be negligible for a proposed action.

4.1.1.3.4.6. Treated Domestic and Sanitary Wastes

Domestic wastes originate from sinks, showers, laundries, and galleys. Sanitary wastes originate from toilets. For domestic waste, no solids or foam may be discharged. In addition, the discharge of all food waste within 12 nmi from nearest land is prohibited. In sanitary waste, floating solids are prohibited. Facilities with 10 or more people must meet the requirement of total residual chlorine greater than 1 mg/l and maintained as close to this concentration as possible. There is an exception in both general permits for the use of marine sanitation devices.

In general, a typical manned platform will discharge 35 gallons per person per day of treated sanitary wastes and 50-100 gallons per person per day of domestic wastes (USEPA, 1993a and b). It is assumed that these discharges are rapidly diluted and dispersed; therefore, no analysis of the impacts will be performed for a proposed action.

4.1.1.3.4.7. Minor Discharges

Minor discharges include all other discharges not already discussed that may result during oil and gas operations. Minor or miscellaneous wastes include desalination unit discharge, blowout preventer fluid, boiler blowdown, excess cement slurry, and uncontaminated freshwater and saltwater. In all cases, no free oil shall be discharged with the waste. Unmanned facilities may discharge uncontaminated water through an automatic purge system without monitoring for free oil. The discharge of freshwater or seawater that has been treated with chemicals is permitted providing that the prescribed discharge criteria are met. No projections of volumes or contaminant levels of minor discharges are made for a proposed action because the impacts are considered negligible.

4.1.1.3.4.8. Vessel Operational Wastes

The USCG defines offshore supply vessels as a vessel propelled by machinery other than steam that is of 15 gross tons and less than 500 gross tons (46 CFR 90.10-40). Operational waste generated from supply vessels that support oil and gas operations include bilge and ballast waters, trash and debris, and sanitary and domestic wastes.

Bilge water is water that collects in the lower part of a ship. The bilge water is often contaminated by oil that leaks from the machinery within the vessel. The discharge of any oil or oily mixtures is prohibited under 33 CFR 151.10; however, discharges may occur in waters greater than 12 nmi if the oil concentration is less than 100 ppm. Discharges may occur within 12 nmi, if the concentration is less than 15 ppm.

Ballast water is used to maintain stability of the vessel and may be pumped from coastal or marine waters. Generally, the ballast water is pumped into and out of separate compartments and is not usually contaminated with oil; however, the same discharge criteria apply as for bilge water (33 CFR 151.10).

The discharge of trash and debris is prohibited (33 CFR 151.51-77) unless it is passed through a comminutor and can pass through a 25-mm mesh screen. All other trash and debris must be returned to shore for proper disposal with municipal and solid waste.

All vessels with toilet facilities must have a marine sanitation device (MSD) that complies with 40 CFR 140 and 33 CFR 149. Vessels complying with 33 CFR 159 are not subject to State and local MSD requirements. However, a State may prohibit the discharge of all sewage within any or all of its waters. Domestic waste consists of all types of wastes generated in the living spaces on board a ship including gray water that is generated from dishwasher, shower, laundry, bath and washbasin drains.

Gray water from vessels is not regulated in the Gulf of Mexico. Gray water should not be processed through the MSD, which is specifically designed to handle sewage.

4.1.1.3.4.9. Assumptions About Future Impacts from OCS Wastes

- The use of SBF will increase, replacing the use of OBF in most situations.
- The discharge of cuttings wetted with SBF (i.e., cuttings with drilling fluid adhered to the surface of the rock fragments) to the seafloor will reduce the volume of cuttings transported to shore for disposal.
- New technologies in deepwater may result in discharges at the seafloor, reducing the potential for water column impacts but increasing impacts at the seafloor.
- The movement into deepwater will result in fewer total platforms but greater volumes of discharges at each platform.

4.1.1.3.5. Trash and Debris

Oil and gas operations on the OCS generate waste materials made of paper, plastic, wood, glass, and metal. Most of this waste is associated with galley and offshore food service operations and with operational supplies such as shipping pallets, containers used for drilling muds and chemical additives (sacks, drums, and buckets), and protective coverings used on mud sacks and drilling pipes (shrink wrap and pipe-thread protectors). Some personal items, such as hardhats and personal flotation devices, are accidentally lost overboard from time to time. Generally, galley, operational, and household wastes are collected and stored on the lower deck near the loading dock in large receptacles resembling dumpsters. These large containers are generally covered with netting to avoid loss and are returned to shore by service vessels for disposal in approved landfills.

The MMS regulations, the USEPA's NPDES general permit, and the USCG regulations implementing MARPOL 73/78 Annex V prohibit the disposal of any trash and debris into the marine environment. Victual matter or organic food waste are allowed to be ground up into small pieces and disposed of overboard from structures located more than 20 km from shore.

Information provided by industry gives some indication on the amount of trash historically generated during the drilling of an average offshore well. Historically, a typical well drilled to about 4,300 m might require 9,300 mud sacks, 100 pails, 250 pallets, 225 shrink wrap applications, and two 55-gallon drums. Most drilling muds are now shipped pre-mixed in reusable bulk tanks. This change has resulted in a significant reduction in the amount of solid waste associated with drilling operations. Still, drilling operations require the most supplies, equipment, and personnel, and therefore, generate more solid waste than production operations.

Over the last several years, companies have employed waste reduction and improved waste-handling practices to reduce the amount of trash offshore that could potentially be lost into the marine environment. Improved waste management practices, such as substituting paper cups and reusable ceramic cups and dishes for those made of styrofoam, recycling offshore waste, and transporting and storing supplies and materials in bulk containers when feasible, are commonplace. Experimental technology, such as reinjection of waste materials reduced to slurry into downhole formations, is also under development. These practices have resulted in a marked decline in accidental loss of trash and debris.

4.1.1.3.6. Air Emissions

The OCS activities that use any equipment that burns a fuel, that transports and/or transfers hydrocarbons, or that results in accidental releases of petroleum hydrocarbons or chemicals, will cause emission of air pollutants. Some of these pollutants are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere.

The criteria pollutants considered here are nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur oxides (SO_x), volatile organic chemicals (VOC), and particulate matter less than 10 microns in size (PM_{10}). Criteria pollutant emissions from OCS platforms and drilling operations are estimated using the emission rates presented in Table 4-11. These emission rates are derived from a 1991-1992 MMS inventory of offshore OCS structures (Steiner et al., 1994).

See Table 4-11 for average annual emission rates from OCS infrastructures in the Gulf of Mexico. Emissions of air pollutants during loading, storage, and transportation of crude oil and gas are calculated using the methodology and emission factors presented in USEPA publication AP-42 of 1985 with supplements A, B, and C. Helicopter emissions are also calculated using the methodology presented in the previous reference.

Flaring is the venting and/or burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation of production equipment. The MMS operating regulations provide for some limited volume, short duration flaring, or venting of some natural gas volumes upon approval by MMS. These operations may occur for short periods (typically 2-14 days) as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the well bore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Emissions from flaring were included in the emissions tables and in the modeling analysis (since platform emissions included flaring along with all other sources). Flaring is not expected to be a significant source of heat, light, or additional air emissions.

4.1.1.3.7. Noise

Noise associated with OCS oil and gas development results from seismic surveys, the operation of fixed structures such as offshore platforms and drilling rigs, and helicopter and service-vessel traffic. Noise generated from these activities can be transmitted through both air and water, and may be extended or transient. Offshore drilling and production involves various activities that produce a composite underwater noise field. The intensity level and frequency of the noise emissions are highly variable, both between and among the various industry sources. Noise from proposed OCS activities may affect resources near the activities. Whether a sound is or is not detected by marine organisms will depend both on the acoustic properties of the source (spectral characteristics, intensity, and transmission patterns) and sensitivity of the hearing system in the marine organism. Extreme levels of noise can cause physical damage or death to an exposed animal; intense levels can damage hearing; loud or novel sounds may induce disruptive behavior or other responses of lesser importance. Loud, manmade underwater sounds are a recent and rapidly increasing perturbation of the marine acoustic environment (Jasny, 1999). It is generally recognized that commercial shipping is a dominant component of the ambient, low-frequency background noise in modern world oceans (Gordon and Moscrop, 1996) and that OCS-related, service-vessel traffic will contribute to this. For the Gulf of Mexico, that contribution to existing shipping noise is likely insignificant (USDOI, MMS, in preparation). Another sound source more specific to OCS operations originates from seismic operations. Airguns produce an intense, but highly localized, sound energy and represent a noise source of possible concern. The MMS has almost completed a programmatic EA on G&G permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference.

Marine seismic surveys direct a low-frequency energy wave (generated by an airgun array) into the ocean floor and record the reflected energy waves' strength and return arrival time. The pattern of reflected waves, recorded by a series of hydrophones embedded in cables towed by the seismic vessel (streamers), can be used to "map" subsurface layers and features. Seismic surveys can be used to check for foundation stability, detect groundwater, locate mineral deposits (coal), and search for oil and gas. Most commercial seismic surveying is carried out for the energy sector (Gulland and Walker, 1998). Two general types of seismic surveys are conducted in the Gulf of Mexico relative to oil and gas operations. High-resolution site surveys collect data up to 1 km deep through bottom sediments and are used for initial site evaluation for potential structures as well as for exploration. This involves a small vessel and perhaps a single airgun source and is also usually restricted to small areas, most often a single lease site.

Seismic exploration and development surveys are often conducted over large survey areas (multiple leases and blocks) and obtain information on geological formations to several thousands meters below the ocean floor. For "2D" surveys, a single streamer (hydrophones) is towed behind the survey vessel, together with a single source (airguns) (Gulland and Walker, 1998). Seismic vessels generally operate at low hull speeds (<10 kn) and follow a systematic pattern during a survey, typically a simple grid pattern for 2D work with lines no closer than half a kilometer.

In simplistic terms, "3D" surveys collect a very large number of 2D slices, perhaps with line separations of only 25-30 m. A 3D survey may take months to complete and involves a precise definition of the survey area and transects, usually a series of passes to cover a given survey area (Caldwell, 2001). In 1984, industry operated the first twin streamers. By 1990, industry achieved a single vessel towing two airgun sources and six streamers. Industry continues to increase the capability of a single vessel, now using eight streamer/dual source configurations and multi-vessel operations (Gulland and Walker, 1998). For exploration surveys, 3D methods represent a substantial improvement in resolution and useful information relative to 2D methods. Many areas in the Gulf of Mexico previously surveyed using 2D have been or will be surveyed using 3D. It can be assumed that for new deepwater areas, 3D surveys will be the preferred method for seismic exploration, until and if better technology evolves.

A typical 3D airgun array will involve 15-30 individual guns. The firing times of the guns are staggered by milliseconds (tuned) in an effort to make the farfield noise pulse as coherent as possible. In short, the intent of a tuned airgun array is to have it emit a very symmetric packet of energy in a very short amount of time, and with a frequency content that penetrates well into the earth at a particular location (Caldwell, 2001). The noise generated by airguns is intermittent, with pulses generally less than one second in duration, for relatively short survey periods of several days to weeks for 2D work and site surveys (Gales, 1982) and weeks to months for 3D surveys (Gulland and Walker, 1998). Airgun arrays produce noise pulses with very high peak levels. The pulses are a fraction of a second and repeat every 5-15 seconds. In other words, while airgun arrays are by far the strongest sources of underwater noise associated with offshore oil and gas activities, because of the short duration of the pulses, the total energy is limited (Gordon and Moscroup, 1996). This is an important factor when evaluating potential effects on marine animals.

At distances of about 500 m and more (farfield), the array of individual guns will effectively appear to be a single point source (Caldwell, 2001). In the past, sound-energy levels were expected to be less than 200 dB re-1µPa-m at distances beyond 90 m from the source (Gales, 1982). Gulland and Walker (1998) state a typical source will output approximately 220 dB re-1µPa-m, although the peak-to-peak source level directly below a seismic array can be as high as 262 dB re-1µPa-m (Davis et al., 1998b). More recently, it has been estimated a typical 240-dB seismic array will have a 180 dB re-1µPa-m level at approximately 225 m from the array (USDOI, MMS, in preparation). The 180 dB re-1µPa-m level is an estimate of the threshold of sound energy that may cause hearing damage in cetaceans (U.S. Dept. of the Navy, 2001). It is unclear which measurements of a seismic pulse provide the most helpful indications of its potential impact on marine mammals (Gordon et al., 1998). Gordon et al. speculate that peak broadband pressure and pulse time and duration would be most relevant at short ranges (hearing damage range) while sound intensity in 1/3 octave bands is a more useful measurement at distance (behavioral effects).

Information on drilling noise in the Gulf of Mexico is unavailable to date. From studies mostly in Alaskan waters, drilling operations often produce noise that includes strong tonal components at low frequencies, including infrasonic frequencies in at least some cases. Drillships are apparently noisier than semisubmersibles (Richardson et al., 1995). Sound and vibration paths to the water are through either the air or the risers, in contrast to the direct paths through the hull of a drillship.

Machinery noise generated during the operation of fixed structures can be continuous or transient, and variable in intensity. Underwater noise from fixed structures ranges from about 20 to 40 dB above background levels within a frequency spectrum of 30-300 Hz at a distance of 30 m from the source (Gales, 1982). These levels vary with type of platform and water depth. Underwater noise from platforms standing on metal legs would be expected to be relatively weak because of the small surface area in contact with the water and the placement of machinery on decks well above the water.

Aircraft and vessel support may further ensonify broad areas. Noise generated from helicopter and service-vessel traffic is transient in nature and extremely variable in intensity. Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters often radiate more sound forward than backward; thus, underwater noise is generally brief in duration, compared with the duration of audibility in the air. In addition to the altitude of the helicopter, water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area and an altitude of about 500 ft while between platforms.

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size, laden or not, and speed. Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. For a given vessel, relative noise also tends to increase with increased speed. Commercial vessel noise is a dominant component of manmade ambient noise in the ocean (Jasny, 1999). Given the amount of vessel traffic from all sources in the Gulf of Mexico, CSA concludes that the contribution of noise from offshore service vessels is a minor component of the total ambient noise level (USDOI, MMS, in preparation). In the immediate vicinity of a service vessel, noise could disturb marine mammals; however, this effect would be limited in area and duration.

4.1.1.3.8. Offshore Transport

4.1.1.3.8.1. Pipelines

Pipelines are the primary method used to transport a variety of liquid and gaseous products between OCS production sites and onshore facilities around the Gulf of Mexico. These products include unprocessed (bulk) oil and gas; mixtures of gas and condensate; mixtures of gas and oil; processed condensate, oil, or gas; produced water; methanol; and a variety of chemicals used by the OCS industry offshore. Pipelines in the Gulf are designated as either trunklines or gathering lines. Gathering lines are typically shorter segments of small-diameter pipelines that transport the well stream from one or more wells to a production facility or from a production facility to a central facility serving one or several leases, e.g., a trunkline or central storage or processing terminal. Trunklines are typically large-diameter pipelines that receive and mix similar production products and transport them from the production fields to shore. A trunkline may contain production from many discovery wells drilled on several hydrocarbon fields. The OCS-related pipelines near shore and onshore may merge with pipelines carrying materials produced in State territories for transport to processing facilities or to connections with pipelines located further inland. Most of the active length of OCS pipelines transport mostly gas (64%); the reminder transport predominately oil (25%).

Over the last 10 years, the average annual installation rate for OCS pipelines was 1,600 km and more than 200 pipelines and pipeline segments. Pipelines in the CPA accounted for 83 percent of the length installed; pipelines in the WPA accounted for 17 percent. The installation rate for pipelines is expected to remain steady; this includes consideration of expansion and replacement of the existing and aging pipeline infrastructure in the Gulf.

Projected Lengths of OCS Pipelines to be Installed during 2003-2042

OCS Program	WPA Proposed Action	CPA Proposed Action
27,600-52,400 km	320-640 km	560-1,040 km

It is expected that pipelines from most of the new offshore production facilities will connect to the existing pipeline infrastructure, which will result in few new pipeline landfalls. Production from a proposed action in the CPA and WPA will contribute 2 percent and 1 percent, respectively, to existing and future pipelines and pipeline landfalls. For the period 2003-2042, a range of 23-38 new landfalls is projected for the OCS Program. For each proposed action, 0-1 new landfalls are projected. See Chapter 4.1.2.1.7 for a discussion of coastal pipelines.

The typical operational life of a pipeline has been estimated to be 20-40 years, but with current corrosion management, that lifetime has been significantly increased. One technique for extending the operational life of a gas pipeline is to periodically treat the inside of the pipe with a corrosion inhibiting substance (CIS). The treatment may be applied as either an aerosol that is pumped in with the production stream or as a liquid "slug" that is pushed through the pipe with a series of mechanized plungers, referred to as a "pigs."

As of August 2001, more than 35,000 km (78%) of the total pipeline length installed were still active. About 22 percent of the total length of pipelines that have been installed in the Gulf was not active (i.e., out of service, abandoned, proposed to be abandoned, or proposed to be removed). From 1991 to 2000, an average of 228 km of pipelines (81 pipeline segments) were abandoned annually.

Removal of pipelines will be rare and will generally involve short lengths. As of August 2001, less than 1 percent of the total length of pipelines installed, or about 300 km, were removed. All pipelines removed were in the CPA, except for 1 km in the WPA. Most pipelines were in water depths of less than 66 ft (20 m); 6 pipelines were in water depths greater than 656 ft (200 m).

Pipelines constructed in water depths <200 ft (60 m) are potential snags for anchors and trawls. Of the pipeline constructed in Federal waters, 58 percent (49% of the WPA and 59% of the CPA) were constructed in water depths ≤200 ft. According to MMS regulations (30 CFR 250.1003(a)(1)), pipelines with diameters ≥$8^5/_8$ inches that are installed in water depths <200 ft are to be buried to a depth of at least 3 ft below the mudline. The regulations also provide for the burial of any pipeline, regardless of size, if MMS determines that the pipeline may constitute a hazard to other uses of the OCS; in the Gulf of Mexico, MMS has determined that all pipelines installed in water depths <200 ft must be buried. The purpose of these requirements is to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, to reduce the risk of fishing gear becoming snagged, and to minimize interference with the operations of other users of the OCS. For lines $8^5/_8$ inches and smaller, a waiver of the burial requirement may be requested and may be approved if the line is to be laid in an area where the character of the seafloor will allow the weight of the line to cause it to sink into the sediments (self-burial). For water depths ≤200 ft, any length of pipeline that crosses a fairway or anchorage in Federal waters must be buried to a minimum depth of 10 ft below mudline across a fairway and a minimum depth of 16 ft below mudline across an anchorage area. Some operators voluntarily bury these pipelines deeper than the minimum.

Where pipeline burial is necessary, a jetting sled will be used. Such sleds are mounted with high-pressure water jets and pulled along the seafloor behind the pipelaying barge. The water jets are directed downward to dig a trench; the sled guides the pipeline into the trench. Such an apparatus can jet pipe at an average of 1.6 km/day. The cross section of a typical jetted trench for the flowline bundles would be about 4 m^2; for deeper burial when crossing a fairway, the cross section would be about 13 m^2. The cross section of a typical jetted trench for the export and interconnecting export pipelines would be about 5 m^2; for a pipeline trench crossing a fairway, the cross section would be about 15 m^2.

Jetting disperses sediments over the otherwise undisturbed water bottom that flanks the jetted trench. The area covered by settled sediment and the thickness of the settled sediment depends upon variations in bottom topography, sediment density, and currents (see also Chapter 4.1.1.3.8.1).

New installation methods have allowed the pipeline infrastructure to extend to deeper water. At present, the deepest pipeline in the Gulf is in 2,300 m water depth. More than 200 pipelines reach water depths of 300 m or more, and almost half of those reach water depths of 800 m or more.

Pipeline installation activities in deepwater areas can be difficult both in terms of route selection and construction. Depending on the location, the sea bottom surface can be extremely irregular and present engineering challenges (for example, high hydrostatic pressure, cold temperatures, and darkness, as well as varying subsurface and bottom current velocities and directions). Rugged seafloor may cause terrain-induced pressures within the pipe that can be operationally problematic, as the oil must be pumped up and down steep slopes. An uneven seafloor could result in unacceptably long lengths of unsupported pipeline, referred to as "spanning," which in turn could lead to pipe failure from bending stress early in the life of the line. It is important to identify areas where significant lengths of pipeline may go unsupported. Accurate, high-resolution geophysical surveying becomes increasingly important in areas with irregular seafloor. Recent advances in surveying techniques have significantly improved the capabilities for accurately defining seafloor conditions, providing the resolution needed to determine areas where pipeline spans may occur. After analyzing survey data, the operator chooses a route that minimizes pipeline length and avoids areas of seafloor geologic structures and obstructions that might cause excessive pipe spanning, unstable seafloor, and potential benthic communities.

The greater pressures and colder temperatures in deepwater present difficulties with respect to maintaining the flow of crude oil and gas through pipelines. Under these conditions, the physical and chemical characteristics of the produced hydrocarbons can lead to the accumulation of gas hydrate, paraffin, and other substances within the pipeline. These accumulations can restrict and eventually block flow if not successfully prevented and/or abated. There are physical and chemical techniques that can be applied to manage these potential accumulations. The leading strategy to mitigate these deleterious effects is to minimize heat loss from the system by using insulation. Other measures include forcing plunger-like "pigging" devices through the pipeline to scrape the pipe walls clean, and the continuous injection of flow-assurance chemicals (e.g., methanol or ethylene glycol) into the pipeline system to minimize the formation of flow-inhibiting substances. However, the great water depths of the OCS and the extreme distance to shoreside facilities make these flow-assurance measures difficult to implement and can significantly increase the cost to produce and transport the product. Companies are continuously looking for and developing new technologies such as electrically and water-heated pipelines and burial of pipelines in deepwater for insulation purposes.

Long-distance transport of multiphase well-stream fluids can be achieved with an effectively insulated pipeline. There are several methods to achieve pipeline insulation: pipe-in-pipe systems, which included electrically and water-heated pipelines; pipe with insulating wrap material; and as previously mentioned, buried pipelines where the soils act as an insulator. The design of all of these systems seeks a balance between the high cost of the insulation, the intended operability of the system, and the acceptable risk level. Such systems minimize the costs, revenue loss, and risks from the following:

- hydrate formation during steady state or transient flowing conditions;
- paraffin accumulation on the inner pipe wall that can result in pipeline plugging or flow rate reductions;
- adverse fluid viscosity effects at low temperatures that lead to reduced hydraulic performance or to difficulties restarting a cooled system after a short shut-in; and
- additional surface processing facilities required to heat produced fluids to aid in the separation processes.

Formation of gas hydrates in deepwater operations is a well-recognized and potentially hazardous operational problem in water depths greater than 1,000 ft (300 m). Seabed conditions of high pressure and low temperature become conducive to gas hydrate formation in deepwater. Gas hydrates are ice-like crystalline solids formed by low-molecular-weight hydrocarbon gas molecules (mostly methane) combining with produced water. The formation of gas hydrates is potentially hazardous because hydrates can restrict or even completely block fluid flow in a pipeline, resulting in a possible overpressure condition. The interaction between the water and gas is physical in nature and is not a chemical bond. Gas hydrates are formed and remain stable over a limited range of temperatures and pressures.

Hydrate prevention is normally accomplished through the use of methanol, ethylene glycol, or triethylene glycol as inhibitors, and the use of insulated pipelines and risers. Chemical injection is sometimes provided both at the wellhead and at a location within the well just above the subsurface safety valve. Wells that have the potential for hydrate formation can be treated with either continuous chemical injection or intermittent or "batch" injection. In many cases, batch treatment is sufficient to maintain well flow. In such cases, it is necessary only to inject the inhibitor at well start-up, and the well will continue flowing without the need for further treatment. In the event that a hydrate plug should form in a well that is not being injected with a chemical, the remediation process would be to depressurize the pipelines and inject the chemical. Hydrate formation within a gas sales line can be eliminated by dehydrating the gas with a glycol dehydrating system prior to input of gas into the sales line. In the future, molecular sieve and membrane processes may also be options for dehydrating gas. Monitoring of the dewpoint downstream of the dehydration tower should take place on a continuous basis. In the event that the dehydration equipment is bypassed because it may be temporarily out of service, a chemical could be injected to help prevent the formation of hydrates if the gas purchaser agrees to this arrangement beforehand.

Hydrocarbon flows that contain paraffin or asphaltenes may occlude pipelines as these substances, which have relatively low melting points, form deposits on the interior walls of the pipe. To help ensure product flow under these conditions, an analysis should be made to determine the cloud point and hydrate formation point during normal production temperatures and pressures. To minimize the formation of paraffin or hydrate depositions, wells can be equipped with a chemical injection system. If, despite treatment within the well, it still becomes necessary to inhibit the formation of paraffin in a pipeline, this can be accomplished through the injection of a solvent such as diesel fuel into the pipeline.

Pigging is a term used to describe a mechanical method of displacing a liquid in a pipeline or to clean accumulated paraffin from the interior of the pipeline by using a mechanized plunger or "pig." Paraffin is a waxy substance associated with some types of liquid hydrocarbon production. The physical properties of paraffin are dependent on the composition of the associated crude oil, and temperature and pressure. At atmospheric pressure, paraffin is typically a semisolid at temperatures above about 100 °F and will solidify at about 50 °F. Paraffin deposits will form inside pipelines that transport liquid hydrocarbons and, if some remedial action such as pigging is not taken, the deposited paraffin will eventually completely block all fluid flow through the line. The pigging method involves moving a pipeline pig through the pipeline to be cleaned. Pipeline pigs are available in various shapes and are made of various materials, depending on the pigging task to be accomplished. A pipeline pig can be a disc or a spherical or cylindrical device made of a pliable material such as neoprene rubber and having an outside diameter nearly equal to the inside diameter of the pipeline to be cleaned. The movement of the pig through the pipeline is accomplished by applying pressure from gas or a liquid such as oil or water to the back or upstream end of the pig. The pig fits inside the pipe closely enough to form a seal against the applied pressure. The applied pressure then causes the pig to move forward through the pipe. As the pig travels through the pipe, it scrapes the inside of the pipe and sweeps any accumulated contaminants or liquids ahead of it. In deepwater operations, pigging will be used to remove any paraffin deposition in the pipelines as a normal part of production operations. Routine pigging will be required of oil sale lines at frequencies determined by production rates and operating temperatures. The frequency of pigging could range from several times a week to monthly or longer, depending on the nature of the produced fluid. In cases where paraffin accumulation cannot be mitigated, extreme measures can be taken in some cases such as coil tubing entry into a pipeline to allow washing (dissolving) of paraffin plugs. If that fails, then it could result in having to replace a pipeline

4.1.1.3.8.2. Barges

Barges may be used offshore to transport oil and gas, supplies such as chemicals or drilling mud, or wastes between shore bases and offshore platforms. Barges are non-self-propelled vessels that must be accompanied by one or more tugs. Because of this, barge transport is usually constrained to shallow waters of the Gulf, close to the shoreline.

Barging of OCS oil from platforms to shore terminals is an option used by the oil industry in lieu of transporting their product to shore via pipeline. A platform operator generally decides at the beginning of a development project whether the production will be barged or piped. Barging is used very infrequently as an interim transport system prior to the installation of a pipeline system.

As of August 2001, eight barge systems were operating in the Gulf, servicing 25 OCS platforms (Figure 3-14). These platforms were located in water depths less than 60 m with the exception of two platforms located in slightly deeper water. Five barge systems operate in the CPA, with one system handling a small amount of oil from the WPA, and three barge systems operate only in the WPA.

About 1 percent of the oil produced in less than 60 m is barged to shore. Eighty percent of barged oil is from leases east of the Mississippi River. An examination of the last 10 years reveals a significant decline in barging activity from an average of 4.5 MMbbl to 1.5 MMbbl per year (Figure 4-4). From 1997 to 2000, the average volume barged remained steady at approximately 1.5 MMbbl per year. The volume of oil barged is projected to remain fairly constant at this level.

Other types of barging operations may occur in connection with OCS operations. Besides barging from platform to shore terminal, a few platform operators choose to barge their oil to other platforms where it is then offloaded to storage tanks and later piped to shore. Recently there has been some barging of oil from deepwater sites during extended well testing; this activity is likely to increase in the future. Storage and barging of the well stream from extended well tests is an alternative to flaring the gas and burning the liquids produced during well testing. No information is currently available on the number of barge trips associated with these other types of offshore oil barging operations. Secondary intracoastal barging of OCS-produced oil from terminal to terminal or from terminal to refinery also occurs along the Gulf Coast and is discussed under the coastal scenario (Chapter 4.1.2.1.8).

Chapter 4.1.2.1.5.2 describes the shore terminals receiving OCS-produced barged oil.

The capacity of oil barges used offshore can range from 5,000 to 80,000 bbl. Barges transporting oil typically remain offshore for as long as one week while collecting oil; each trip is assumed to be five days.

It is assumed that barging will account for less than 1 percent of the oil transported for the entire OCS Program and each proposed action. Tables 4-2, 4-3 and 4-4 provide the percentages of oil barged to shore by subarea for the proposed actions and the Gulfwide OCS Program. Tables 4-6, 4-5 and 4-7 provide the percentages of oil barged to shore for the Gulfwide OCS Program by planning area.

Assuming that about eight barge systems will continue operating in the Gulf and that the barge will go out once a month to pick up oil from the platforms in each system nearly 100 trips are projected to occur annually Gulfwide. It is assumed that the WPA activities will account for 1 percent of these trips—30 trips spread over a 31-year production period. The CPA activities will account for 2 percent of these trips—60 trips spread over a 31-year production period. Only primary barging activity from offshore production platforms to onshore terminals is considered in these projections.

4.1.1.3.8.3. Oil Tankers

Shuttle tanker transport of Gulf of Mexico OCS-produced oil has not occurred to date. Tankering is projected for some future OCS operations located in deepwater beyond the existing pipeline network. In early 1997, discussions between industry and MMS began concerning the feasibility of floating production, storage, and offloading (FPSO) systems and associated tanker transport of OCS-produced oil in the Gulf of Mexico. The FPSO's are floating production systems that store crude oil in tanks located in the hull of the vessel and periodically offload the crude to shuttle tankers or ocean-going barges for transport to shore. The FPSO's may be used to develop marginal oil fields or used in areas remote from the existing OCS pipeline infrastructure. A workshop was held in April 1997 to identify significant issues related to four areas: environmental effects, conservation of oil and gas resources, technology, and regulatory framework. Subsequent to the workshop, MMS prepared an EIS to evaluate potential environmental effects of the proposed use of FPSO systems and tankering in the deepwater CPA and WPA. The MMS funded a comparative risk analysis that looked at risks associated with FPSO's and tankering in relation to risks associated with three currently accepted deepwater production systems and oil pipelines. A joint MMS/USCG/industry team has reviewed the existing MMS and USCG regulatory framework applicable to FPSO's and shuttle tankering.

Shuttle tankers would be used to transport crude oil from FPSO production systems to Gulf Coast refinery ports or to offshore deepwater ports such as the Louisiana Offshore Oil Port (LOOP). The shuttle tanker design and systems would be in compliance with USCG regulations. Under the Jones Act and OPA 90 requirements, shuttle tankers would be required to be double hulled. Shuttles can have internal propulsion systems, or they may use other propulsion system configurations, such as an articulated tug barge (ATB). The ATB's involve the connectable/disconnectable integration of a tug-type vessel to a recess in the stern of a large-capacity barge. Shuttle tankers also vary in size. In the Gulf, the maximum size of shuttle tankers is limited primarily by the 34- to 47-ft water depths of U.S. Gulf Coast refinery ports. Due to these depth limitations, shuttle tankers are likely to be 500,000-550,000 bbl in cargo capacity.

Offloading operations involve the arrival, positioning, and hook-up of a shuttle tanker to the FPSO. Shuttle tankers could maintain their station during FPSO offloading operations using several techniques. These include side-by-side mooring to the FPSO, use of a hawser mooring system with or without thruster assist, or by use of a dynamic positioning system that maintains the vessel's station by use of thrusters rather than mooring lines. Hawser mooring systems used in a tandem offloading configuration is the most likely configuration for FPSO offloading operations in the Gulf of Mexico. Offloading would occur at an average rate 50,000 barrels per hour (BPH). During the FPSO offloading procedure, the shuttle tanker would continue to operate its engines in an idle mode so that any necessary maneuvers of the vessel could be promptly executed.

Tandem offloading would occur under maximum wave height limitations of 3.5 m (11.5 ft) for hook up/connection and 4.5 m (14.8 ft) for disconnect. These wave height limitations are currently being used in the North Sea. Hook-up is accomplished by the use of a retractable hose and a messenger line that is fired from the FPSO to the shuttle tanker via compressed air. The hawser and hose(s) are then pulled over to the shuttle tanker and connected. Cargo oil would be offloaded to the shuttle tanker using the FPSO's main cargo pumps, with oil being routed through a deck line to a stern offloading station, and then through a floating hose to the midship loading manifold of the tanker. Safety features, such as marine break-away offloading hoses and emergency shut-off valves, will be incorporated in order to minimize the potential for, and size of, an oil spill. In addition, weather and sea-state limitations will be established to further ensure that hook-up and disconnect operations will not lead to accidental oil release. A vapor recovery system between the FPSO and shuttle tanker would be employed to minimize release of fugitive emissions from cargo tanks during offloading operations.

The number of shuttle tanker trips to port in a given year is primarily a function of the FPSO production rate and the capacity of supporting shuttle tankers. Considering an FPSO operating at a peak production rate of 150,000 bbl/day, supported by shuttle tankers of 500,000 bbl capacity, offloading would occur once every 3.3 days. This would equate to 54.75 million bbl production with 110 offloading events and shuttle tanker transits to Gulf coastal or offshore ports annually.

Proposed Action Scenario: It is estimated that no tankering will occur as a result of a single proposed action in the CPA or WPA. An FPSO and associated tankering is assumed to support production from leases resulting from multiple sales; any one proposed action is expected to contribute incrementally to tankering under the OCS Program.

OCS Program Scenario: To develop a scenario for analytical purposes, the following assumptions are made regarding future OCS oil transportation by shuttle tanker:

- advances in pipelaying technology will keep pace with the expansion of the oil industry into the deeper waters of the Gulf beyond the continental slope;
- all produced gas will be piped;
- tankering will not occur from operations on the continental shelf;
- tankering will only take place from marginal fields or fields in areas remote from the existing OCS pipeline infrastructure; and
- offloading frequency for an FPSO would be once every three days during peak production.

These assumptions result in an estimate that 5-10 percent of the oil will be tankered from the OCS Program in water depths greater than 200 m in the CPA and WPA. It is projected that 500-1,000 offloading operations and shuttle tanker transits will occur annually from OCS Program activities during the peak years of FPSO use in the CPA and WPA.

4.1.1.3.8.4. Service Vessels

Service vessels are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. In addition to offshore personnel, service vessels carry cargo (i.e., freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, and food) offshore. A trip is considered the transportation from a service base to an offshore site and back, in other words a round trip. Based on MMS calculations, each vessel makes an average of three round trips per week for 40 weeks in support of drilling an exploration well and for 35 weeks in support of drilling an a development well. A platform is estimated to require two vessel trips per week over its 20-year production life. All trips are assumed to originate from the service base.

There are currently approximately 376 supply vessels operating in the Gulf of Mexico. Over the 40-year life of the proposed actions, supply vessels will retire and replacement vessels will be built. In general, the new type of vessels built will continue to be larger, deeper drafted, and more technologically advanced for deepwater activities. In the short term, if any oversupply of deepwater vessels develops, some of the smaller deepwater vessels (200-220 ft) will be forced to work in shallow waters where they will compete with the older 180-ft vessels for jobs. Oversupply could result from lower OCS activity (decreased demand) or from construction of too many vessels (increased supply).

Support of deepwater operations will continue to be the future of the service-vessel industry. Compared to shelf-bound service vessels, deepwater service vessels have improved hull designs (increased efficiency and speed), a passive computerized anti-roll system, drier and safer working decks, increased cargo capacity (water, cement, barite, drilling muds, etc.), increased deck cargo capability, increased cargo transfer rates to reduce the time and risk alongside structures (e.g., TLP), dual and independent propulsion systems, true dynamic positioning system, fuel and NO_x efficient engines, and Safety of Life at Sea (SOLAS) capability (*WorkBoat*, 1998). Service vessels primarily used in deepwater are offshore supply vessels (OSV), fast supply vessels, and anchor-handling towing supply/mooring vessels (AHTS) (*WorkBoat*, 2000). Other deepwater specialty service vessels include well stimulation vessels. The OSV's and AHTS's carry the same type of cargo (freshwater, fuel, cement, barite, liquid drilling fluids, tubulars, equipment, food, and miscellaneous supplies) but have different functions. The AHTS's also differ from the supply vessels by their deepwater mooring deployment and towing capabilities.

Consolidation may continue within the industry as smaller operations are unable to compete with the larger, more advanced companies. Also, issues such as logistics and boat pooling will continue to emerge as bottom line accounting persists to direct the offshore oil and gas industry.

Proposed Action Scenario: Service-vessel trips projected for a proposed action in the CPA are 63,000-111,000 trips, with most trips going to the western subarea for the 0-60 m water depth range (Table 4-2). This equates to an average annual rate of 2,000 - 3,000 trips. A proposed action in the WPA is estimated to generate 25,000-36,000 service-vessel trips or about 1,000 trips annually (Table 4-3).

OCS Program Scenario: The projected number of service-vessel trips estimated for the OCS Program is 11,889,000-12,479,000 over the 2003-2042 period (Table 4-4). This equates to an average rate of 296,000-312,000 trips annually.

4.1.1.3.8.5. Helicopters

Helicopters are one of the primary modes of transporting personnel between service bases and offshore platforms, drilling rigs, derrick barges, and pipeline construction barges. Helicopters are routinely used for normal crew changes and at other times to transport management and special service personnel to offshore exploration and production sites. In addition, equipment and supplies are sometimes transported. A trip is considered the transportation from a helicopter hub to an offshore site and back, in other words a round trip.

Deepwater operations require helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating costs. There are several issues of concern for the helicopter industry's future. Since the tasks the offshore helicopter industry provides are the same tasks supply vessels provide, they are competition for one another. Fast boats are beginning to erode the helicopter industry's share of the offshore transportation business, particularly in shallow water. The exploration and production industry is outsourcing more and more operations to oil-field support companies who are much more cost conscious and skeptical about the high cost of helicopters. Another consideration for the helicopter industry is new technology such as subsea systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

Proposed Action Scenario: Helicopter trips projected for a proposed action in the CPA are 220,000-870,000 trips (Table 4-2). This equates to an average annual rate of 5,500-21,750 trips. A proposed action in the WPA is projected to generate 110,000-410,000 helicopter trips or 3,000-10,000 trips annually (Table 4-3).

OCS Program Scenario: The projected number of helicopter trips for the OCS Program is 27,997,000-50,692,000 trips over the 2003-2042 period (Table 4-4). This equates to an average rate of 700,000-1,267,000 trips annually.

To meet the demands of deepwater activities, the offshore helicopter industry is purchasing new helicopters that travel farther and faster, carry more personnel, are all-weather capable, and have lower operating cost. Also, instead of running their own fleets, oil and gas companies are increasingly subcontracting all helicopter support to independent contractors who are very cost conscience. The number of helicopters operating in the Gulf of Mexico is expected to decrease in the future, and helicopters that do operate are expected to be larger and faster.

4.1.1.3.8.6. Alternative Transportation Methods of Natural Gas

As the country's gas consumption is expected to increase by 65 percent over the next 20 years (USDOE, EIA, 2001b), industry is looking at alternative methods of transporting OCS gas in the Gulf of Mexico. These methods involve transporting natural gas as liquefied natural gas (LNG) or compressed natural gas (CNG) in specially designed vessels. The focus has been on deepwater where it is costly and technically challenging to install pipelines to transport gas. The LNG and CNG options may make it economically viable to produce marginal gas fields. The CNG option may also be an economical way of transporting “stranded” associated gas instead of the gas being flared or reinjected. Although both technologies could bring gas to shore, most discussions suggest the use of offshore terminals and the existing nearshore pipeline infrastructure. The offloading platforms would require USCG-designated safety zones with “no surface occupancy” restrictions for oil and gas exploration, development, and production operations.

In the LNG process, gas is super-cooled, reducing its volume to a fraction of its gaseous state. Then, tankers with specially designed cargo holds transport the LNG to terminals for regasification. At present, LNG is being imported into four existing U.S. terminals, and more terminals are proposed. The LNG imports already travel through the Gulf of Mexico to one of the existing terminals at Lake Charles, Louisiana.

The CNG process uses less of the energy because liquefaction and regasification are not required as it is with LNG. The CNG technology is not currently being used to transport gas. The first application of CNG will be a pilot project shipping gas from Venezuela or Trinidad to Curacao (Cran and Stenning Technology Inc., 2001).

4.1.1.3.9. Hydrogen Sulfide and Sulfurous Petroleum

Sulfur may be present in oil as elemental sulfur, within hydrogen sulfide (H_2S) gas, or within organic molecules, all three of which vary in concentration independently. Although sulfur-rich petroleum is often called “sour” regardless of the type of sulfur present, the term “sour” should properly be applied to petroleum containing appreciable amounts of H_2S, and “sulfurous” should be applied to other sulfur-rich petroleum types. Using this terminology, the following matrix of concerns is recognized:

Potentially Affected Endpoint	Sour Natural Gas	Sour Oil	Sulfurous Oil
Engineering	Equipment and pipeline corrosion	Equipment and pipeline corrosion	N/A
On-Platform Industrial Hygiene	Irritation, injury, and lethality from leaks	Irritation, injury, and lethality from outgassing from spilled oil	Irritation, injury, and lethality from exposure to sulfur oxides produced by flaring
Off-Platform General Human Health and Safety	Irritation, injury, and lethality from leaks	Irritation, injury, and lethality from outgassing from spilled oil	Irritation, injury, and lethality from exposure to sulfur oxides produced by flaring
Marine and Coastal Species and Habitats	Irritation, injury, and lethality from leaks	Synergistic amplification of oil-spill impacts from outgassing	No effects other than impacts hydrocarbon contact and acid rain

Sour Oil, Sour Gas, and Sulfurous Oil in the Gulf of Mexico

Occurrence

Sour oil and gas occur sparsely throughout the Gulf of Mexico OCS (e.g., about 65 operations had encountered H_2S-bearing zones in the Gulf of Mexico as of mid-1998), but principally offshore the Mississippi Delta (Louisiana), Mississippi, and Alabama. Occurrences of H_2S offshore Texas are in Miocene rocks and occur principally within a geographically narrow band. The occurrences of H_2S offshore Louisiana are mostly on or near piercement domes with caprock and are associated with salt and gypsum deposits. Examination of industry exploration and production data show that H_2S concentrations vary from as low as fractional parts per million (ppm) in either oil or gas to 650,000 ppm in the gas phase of a single oil well near the Mississippi Delta. The next highest concentrations of H_2S encountered to date are in the range of 20,000-55,000 ppm in some natural gas wells offshore Mississippi/Alabama.

There is some evidence that petroleum from deepwater plays may be sulfurous, but there is no evidence that it is sour.

Only 5 percent of all wells drilled on the OCS to date have penetrated sediments below 15,000 ft subsea. The MMS estimates that there could be 5-20 tcf of recoverable gas resources below 15,000 ft. Deep gas reservoirs on the Gulf of Mexico continental shelf are likely to have high corrosive content, including H_2S. To encourage exploration and development of deep gas prospects on the continental shelf, MMS offered incentives in the form of royalty relief on deep gas production from any new leases issued in Lease Sale 178 (March 2001). Such royalty relief may well be extended to deep gas production on other existing and future leases.

Treatment (Sweetening)

Removal of H_2S from sour petroleum may proceed in one of two ways. The product can either be "sweetened" (removal of H_2S from the hydrocarbons) offshore or it can be transported onshore to a processing facility equipped to handle H_2S hydrocarbons, where the product is sweetened. Several processes based on a variety of chemical and physical principles have been developed for gas sweetening. The processes include solid bed absorption, chemical solvents (e.g., amine units), physical solvents, direct conversion of H_2S to sulfur (e.g., Claus units), distillation, and gas permeation (Arnold and Stewart, 1988). Gas streams with H_2S or SO_2 are frequently treated offshore by amine units to reduce the corrosive properties of the product. A by-product of this process is a concentrated acid gas stream, which is frequently treated as a waste and flared if SO_2 emissions are not of concern. In cases where SO_2 emissions must be minimized, other options for handling acid gas must be sought. Sulfur recovery units to further process the H_2S to elemental sulfur or reduced sulfur compounds is a common method of treating acid gas streams. Reinjection of acid gas is an option that has also been considered. The feasibility of reinjecting acid gas in the offshore environment has not been demonstrated. In addition, MMS conservation requirements may not allow reinjection of this gas. Another option would be to send the untreated gas to shore for treatment; this requires the use of "sour gas" pipelines built to handle the highly corrosive materials.

Requirements for Safety Planning and Engineering Standards

The MMS reviews all proposed actions in the Gulf of Mexico OCS for the possible presence of H_2S. Activities found to be associated with a presence of H_2S are subjected to further review and requirements. Federal regulations at 30 CFR 250.417 require all lessees, prior to beginning exploration or development operations, to request a classification of the potential for encountering H_2S. The classification is based on previous drilling and production experience in the areas surrounding the proposed operations, as well as other factors. All operators on the OCS involved in production of sour gas or oil (i.e., greater than 20 ppm H_2S) are also required to file an H_2S contingency plan. This plan delimits procedures to ensure the safety of the workers on the production facility. In addition, all operators are required to adhere to the National Association of Corrosion Engineers' (NACE) *Standard Material Requirement MR.01-75-96 for Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment* (NACE, 1990). These engineering standards serve to enhance the integrity of the infrastructure used to produce the sour oil and gas, and further serve to ensure safe operations. The MMS has issued a final rule governing requirements for preventing hydrogen sulfide releases, detecting and monitoring hydrogen sulfide and sulfur dioxide, protecting personnel, providing warning systems, and establishing requirements for hydrogen sulfide flaring. The rule went into effect on March 28, 1997. An associated NTL (98-16) titled "Hydrogen Sulfide (H_2S) Requirements" was issued on August 10, 1998, to provide clarification, guidance, and information on the revised requirements. The NTL provides guidance on sensor location, sensor calibration, respirator breathing time, measures for protection against sulfur dioxide, requirements for classifying an area for the presence of H_2S, requirements for flaring and venting of gas containing H_2S, and other issues pertaining to H_2S-related operations.

Environmental Fate of H_2S

Atmospheric Release

Normal dispersion mechanisms in the surface mixed layer of the atmosphere (wind, etc.) cause natural gas leaks and associated H_2S to disperse away from release sites. The MMS reviews of proposed sour gas operations are based on the conservative assumptions of horizontal, noncombusted releases to achieve environmentally conservative results, although vertical release or combustion of the gas plume (greatly reducing potential exposure) would be possible. Both simple Gaussian estimation techniques (conforming to air quality rules) and more rigorous analytical modeling are used in the MMS review of activities associated with a presence of H_2S. For a very large facility (throughput on the order of 100 MMcfd of produced natural gas) with high concentration levels (on the order of 20,000 ppm) and using very calm winds (speed of <1 m/sec), H_2S levels reduce to 20 ppm at several kilometers from the source; H_2S levels are reduced to 500 ppm at 1 km. Most “sour gas” facilities have H_2S concentrations below 500 ppm, which reduces to 20 ppm within the dimensions of a typical platform (or considerably less).

Aquatic Release

Hydrogen sulfide is soluble in water with 4,000 ppm dissolving in water at 20°C and one atmosphere pressure. This implies that a small sour gas leak would result in almost complete dissolution of the contained H_2S into the water column. Larger leaks would result in proportionally less dissolution, depending on turbulence, depth of release, and temperature; and H_2S could be released into the atmosphere if the surrounding waters reach saturation or the gas plume reaches the surface before complete dissolution. Because the oxidation of H_2S in the water column takes place slowly (on the order of hours), the chemical oxygen demand of H_2S is spread out over a long time interval (related to the ambient current speed) and should not create appreciable zones of hypoxia; except, in the case of a very large, long-lived submarine release.

H_2S Toxicology

Humans

The Occupational Safety and Health Administration’s permissible exposure limit for H_2S is 20 ppm. A permissible exposure limit is an allowable exposure level in workplace air averaged over an 8-hour workshift. The American Conference of Governmental Hygienists recommends a time weighted average concentration of 10 ppm. The time-weighted average is a concentration for a normal 8-hour workday to which nearly all workers may be repeatedly exposed, day after day, without adverse affect. This is 30 times lower than the “immediately dangerous to life and health” level of 300 ppm set by the National Institute for Occupational Safety and Health. Despite a normal human ability to smell H_2S at levels below 1 ppm, H_2S is considered to be an insidious poison because the sense of smell rapidly fatigues, failing to detect H_2S after continued exposure. Although there are many different systems of classifying exposure levels and their associated health risks, MMS has synthesized these into a single, simple set of concentration levels to be used in identifying and assessing exposure risks:

Atmospheric Exposure Levels (volume fractions)	Characteristic Human Health Impact	Protective Measures Taken by MMS at this Level
20 ppm	Irritation within minutes	Operator required to develop and file “H_2S Contingency Plan”
100 ppm	Injury within minutes	
500 ppm	Death within minutes	Operator required to model atmospheric dispersion of total, horizontal, noncombusted rupture

Wildlife

While impacts on humans are well documented, the literature on the impact of H_2S on wildlife is sparse, with no information available for marine mammals and turtles.

In general, birds seem more tolerant of H_2S than mammals, indicating that birds may have a higher blood capacity to oxidize H_2S to nontoxic forms. In tests with white leghorn chickens, all birds died when inhaling H_2S at 4,000 ppm. At 500 ppm, no impact was observed on ventilation, while between 2,000 and 3,000 ppm respiratory frequency and tidal volume become irregular and variable in these birds (Klentz and Fedde, 1978). In the western United States, oil production and geothermal operations often flare or vent pipes to release the natural gases accumulated during drilling, storage, and pipeline operations, with significant impacts on wildlife (Maniero, 1996). Numerous instances of dead birds at the release site have been reported in the literature; extremely high concentrations of H_2S would occur at these sites.

Fish

Fish will strongly avoid any water column that is contaminated with H_2S, provided an escape route is available. In terms of acute toxicity testing, fish can survive at levels reaching 0.4 ppm (Van Horn, 1958; Theede et al., 1969). Walleye eggs (*Stizostedion vitreum*) did not hatch at levels from 0.02 to 0.1 ppm (USEPA, 1986). The hatchability of northern pike (*Esox lucius*) was substantially reduced at 25 ppb with complete mortality at 45 ppb. Northern pike fry had 96-hour LC_{50} values that varied from 17 to 32 ppb at O_2 levels of 6 ppm. Sensitive eggs and fry of northern pike exhibited no observable effects at 14 and 4 ppb, respectively (Adelman and Smith, 1970; USEPA, 1986). In a series of tests on the eggs, fry, and juveniles of walleyes, white suckers (*Catostomus commersoni*), and fathead minnows (*Pimephales promelas*), with various levels of H_2S from 2.9 to 12 ppb, eggs were the least sensitive while juveniles were the most sensitive. In 96-hour bioassays, fathead minnows and goldfish (*Carassius auratus)* varied greatly in tolerance to H_2S with changes in temperature (Smith et al., 1976; USEPA, 1986). Pacific salmon (*Oncorhynchus sp.*) experienced 100 percent mortality within 72 hours at 1 ppm.

On the basis of chronic toxicity testing, juveniles and adults of bluegill (*Lepomis macrochirus*) exposed to 2 ppb survived and grew normally. Egg deposition in bluegills was reduced after 46 days of exposure to 1.4 ppb (Smith et al., 1976; USEPA, 1986). White sucker eggs were hatched at 15 ppb, but juveniles showed growth reductions at 1 ppb. Safe levels for fathead minnows were between 2 and 3 ppb. For *Gammarus pseudolimnaeus* and *Hexagenia limbata*, 2 and 15 ppb, respectively, were considered safe levels (USEPA, 1986).

4.1.1.3.10. Workover Operations and Other Well Activities

Workover operations are conducted on a well, after the initial well completion, in order to service, maintain, or restore the productivity of the well; to evaluate a geologic formation or reservoir; or to abandon the well. Examples of workover operations are acidizing the perforated interval in the casing, plugging back, squeezing cement, milling out cement, jetting the well in with coiled tubing and nitrogen, and setting positive plugs to isolate hydrocarbon zones. It is estimated that about 20 percent of all workover operations will require a jack-up rig or other major rig. Workovers on subsea completions require that a rig be moved on location to provide surface support. Workovers can take from a few days to several months to complete, with an average of about 5-15 days. Historical data suggest that each producing well averages one workover or other well operation/treatment about every 4 years (USEPA, 1993a and b). Current oil-field practices include preemptive procedures or treatments that reduce the number of workovers required for each well. The MMS's projections suggest that a development well may expect to have 6-9 workovers or other well activities during its lifetime. Note that these data include well abandonment procedures as a workover operation.

Examples of other well operations include well completions, well treatments, and well abandonments. Well completion is the process of installing the downhole equipment to allow production of oil or gas from the hydrocarbon-bearing formation. Examples of completion activities include setting and cementing the casing, perforating the casing and surrounding cement, installing production tubing and packers, and gravel-packing the well. Completions are expected to occur on approximately 80 percent of the development wells drilled. Well treatments are done to improve well productivity. In the Gulf of

Mexico, acidizing is the most common well treatment. There are two types of well abandonment operations–temporary and permanent. An operator may temporarily abandon a well to drill additional delineation wells to determine if a prospect is feasible; to save the well bore for a future sidetrack to a new geologic bottom hole location; or while waiting on design, construction, and installation of production equipment and facilities. The operator must meet specific requirement to temporarily abandon a well (30 CFR 250.703). Permanent abandonment operations are undertaken when a well bore is of no further use to the operator (i.e., the well's producible hydrocarbon resources have been economically depleted). During permanent abandonment operations, equipment is removed from the well, and specific intervals in the well are plugged with cement. There will be one permanent abandonment operation per well.

CPA Proposed Action Scenario: Table 4-2 shows there are 726-1,441 workovers projected as a result of a proposed action in the CPA. The projected number of workovers is a function of development wells and will follow the same trends as development wells.

WPA Proposed Action Scenario: Table 4-3 shows there are 398-681 workovers projected as a result of a proposed action in the CPA. The projected number of workovers is a function of development wells and will follow the same trends as development wells.

OCS Program Scenario: Table 4-4 shows there are 148,300-167,000 workovers projected as a result of the gulf-wide OCS Program. The projected number of workovers is a function of development wells and will follow the same trends as development wells.

4.1.1.4. Structure Decommissionings/Removals

Lessees are required to remove all structures and related underwater obstructions from their Federal OCS leases within one year after the lease is terminated or relinquished, unless there are mitigating circumstances to be considered by the Regional Supervisor. For example, structures located on the seafloor in waters exceeding 800 m in depth may be left in place; however, such requests are coordinated with the U.S. Navy. Under normal circumstances, MMS regulations require lessees to sever all components at least 5 m below the seafloor to ensure that no part of the structure or its appurtenances will be exposed to and interfere with commercial fishing. Structure removal operations take a day to several weeks to complete once decommissioning commences. For fixed production platforms, this occurs at the end of a platform's 15- to 30-year lifespan.

Fixed platforms and compliant towers anchored to the seafloor by steel pilings are the dominant structures in water depths less than 400 m. Because these platforms must withstand probable hurricane conditions over their designed life span, the structures are designed and constructed to avoid collapsing under such adverse conditions. Consequently, these fortified structures often necessitate the use of explosives for the decommissioning process (severing the structure's pilings and well conductors and removal of equipment).

Structures placed in waters deeper than 400 m include compliant towers and floating structures such as tension-leg platforms, spar's, or FPSO's. Compliant towers, which may be placed in as much as 800 m of water, may require explosives for their removal. Floating production structures will typically host a series of subsea systems that may include an array of subsea wells, manifolds, central umbilicals, and flowlines that can be located many miles away from the host facility. It is presently not known whether explosives will be used to remove some of these structures, particularly since pending regulations would allow for some subsea structures to remain on the seafloor in waters exceeding 800 m in depth. Demolition experts indicate, however, that anchoring systems used to secure floating production structures to the seafloor may be severed using small explosive charges when such structures are decommissioned.

From 1996 to 2001, approximately 43-70 percent of fixed structures were removed using explosives. Approximately 92 percent of the structures removed using explosives during this period were located in less than 60 m of water. However, the number of structure removals using explosives in waters deeper than 60 m is expected to increase. Not included in these numbers are the numerous exploratory wells that are abandoned, sometimes using explosive charges to sever the well stub. The number of well stubs removed using explosives is unknown at this time.

Structures and well stubs that are not removed using explosives typically involve other removal techniques (e.g., cutting the legs and casing strings with an underwater cutting tool). Examples of current nonexplosive techniques to sever pilings of offshore structures include mechanical-cutting (also used for well casings) and torch-cutting (by divers) operations. Nonexplosive removals pose a danger to divers working in the vicinity of structures being severed. Additional information concerning explosive removal of offshore structures can be found in Chapter 4.1.1.4.2.

The MMS and NOAA Fisheries have conferred extensively in the development of structure removal precautions. The NOAA Fisheries has instituted a comprehensive program to protect sea turtles and cetaceans. If sea turtles are observed in the vicinity of structures slated for removal, detonation of the explosives is postponed until the animals are removed or they leave the area of potential impact. Likewise, if cetaceans are observed in the vicinity of a removal site, the detonations are postponed until the animals have vacated the area.

Since NOAA Fisheries' protective observer program began in 1986, explosive removals have impacted only two sea turtles. The first event involved a sea turtle that was observed drifting below the water surface 1.5 hours after the explosive removal of a structure in 1986 (Gitschlag and Renaud, 1989). Only one other injured turtle has been observed since 1987, when monitoring became mandatory (NRC, 1996). In 1991, within one minute after the detonation of explosives during a decommissioning operation, a loggerhead turtle surfaced 5-30 m from the structure with a fracture down a portion of its carapace. No cetacean has been reported as injured since the observer program was implemented.

In October 1995, NOAA Fisheries issued regulations authorizing and governing the "taking" of bottlenose and spotted dolphins incidental to the removal of oil and gas drilling and production structures in State waters and on the Gulf of Mexico OCS (*Federal Register*, 1995a). Letters of Authorization for Incidental Take must be requested from, and issued to, individual applicants (operators) to conduct the activities (structure removals) pursuant to the regulations.

Not only are operators required to remove structures or objects emplaced on the OCS once a lease is terminated, they must also verify that the site is clear of any obstructions that may conflict with other uses of the OCS. The MMS NTL 98-26, "Minimum Interim Requirements for Site Clearance (and Verification) of Abandoned Oil and Gas Structures in the Gulf of Mexico," provides the requirements for site clearance. The lessee must develop, and submit to the MMS for approval, a procedural plan for the site clearance verification procedures. For platform and caisson locations in water depths of less than 91 m (300 ft), the sites must be trawled over 100 percent of the designated area in two directions (i.e., N-S and E-W). Individual well-site clearances may use high-frequency (500 kHz) sonar searches for verification. Site-clearance verification must take place within 60 days after structure removal operations have been conducted.

Proposed Action Scenario: Tables 4-2 and 4-3 show platform removals by water-depth subarea. All structures installed as a result of a proposed action in the CPA (28-49 structures total) or WPA (11-15 structures total) are assumed to be removed by the end of the 40-year life of a proposed action. It is estimated that 16-29 production structures installed landward of the 800-m isobath will be removed using explosives as a result of a proposed action in the CPA. Likewise, 5-7 production structures installed landward of the 800-m isobath as a result of a proposed action in the WPA are likely to be removed using explosives. It is anticipated that multiple appurtenances will not be removed from the seafloor if placed in waters exceeding 800 m. Federal regulations allowing for the abandonment of structures in waters deeper than 800 m are being formalized. An estimate of the well stubs and other various subsea structures that may be removed using explosives is not possible at this time.

OCS Program Scenario: Tables 4-4 to 4-7 show the number of structures removed by water-depth subarea for the total OCS Program and by planning area. The number of structures to be removed in the next several decades is expected to exceed the number of production structures installed (Pulsipher et al., 2001). It is estimated that a total of 943-1,174 production structures will be removed from the WPA during 2003-2042. It is estimated that 629-783 production structures installed landward of the 800-m isobath in the WPA will be removed using explosives during 2003-2042. It is estimated that a total of 5,350-6,110 production structures will be removed from the CPA during 2003-2042. The number of production structures installed landward of the 800-m isobath in the CPA to be removed using explosives during the interval of 2003-2042 is estimated at 3,676-4,183. It is estimated that a total of 10-12 production structures will be removed from the EPA during 2003-2042. Explosive removal will not be used in the EPA. An unknown number of well stubs and subsea structures may be removed using explosives; an estimate is not possible at this time.

4.1.1.4.1. Explosive Removal Disturbance

Possible injury or death to sealife (e.g., sea turtles) from detonating explosives below the seafloor extends at least 915 m from a decommissioning site and upward to the sea surface (Klima et al., 1988). For structure removals requiring the use of explosives, explosive packages are sometimes built to "shape" or "focus" the energy in a narrow zone thus decreasing the amount of explosive required to sever a piling or casing string. The operator must consider the specific conditions (design, water depth, etc.) at each structure when planning its removal. One must also consider that some nonexplosive decommissioning operations are hazardous to divers.

Explosives used to sever and remove structures release energy into the environment in the form of a pressure wave and noise emanating from the explosive charge. Because the resulting pressure wave and noise may harass, harm, or kill protected species of fishes, sea turtles, or marine mammals, MMS and NMFS have conferred over the use of explosives for removing structures and have instituted a comprehensive program of mitigation measures. For example, if sea turtles, dolphins, or whales are observed in the vicinity of structures to be removed, detonation of the explosives must be postponed until the animals are removed or leave the impact area. No cetaceans have been documented as injured or killed since the mitigation measures became mandatory. Since 1986, NMFS observers have documented five loggerhead sea turtles as impacted during explosive removals. Two sea turtles were documented as impacted during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996), one in 1997 (Gitschlag, personal communication, 1999), one in 1998 (Shah, personal communication, 1998), and one in 2001 (Gitschlag, personal communication, 2001).

In October 1995, NMFS issued regulations authorizing and governing the "taking" of bottlenose and spotted dolphins by harassment and incidental to the removal of oil and gas structures in State waters and on the Gulf of Mexico OCS. Letters of Authorization for Incidental Take must be requested from, and issued to, individual applicants (operators) to conduct the activities (structure removal using explosives) pursuant to the regulations.

With the advancement of petroleum exploration and production into deeper waters seaward of the continental shelf, MMS anticipates that some structures fixed or anchored on the continental slope and seaward (beyond the continental shelf) may require the use of explosives when removed in the future. Waters over the continental slope and seaward are inhabited by a variety of cetacean species, including the endangered sperm whale. The current mitigation measures for structure removals using explosives were designed for water depths of less than 50-60 m. Consequently, the MMS is actively working with industry and NOAA Fisheries to develop mitigation measures to detect and protect marine mammals (e.g., sperm whale) and sea turtles (e.g., leatherback sea turtle), regardless of water depth, during decommissioning activities that require explosives to remove the structures.

Proposed Action Scenario: Explosives used to remove structures will disturb the environment because of the unnatural pressure wave and noise that this activity generates. It is estimated that 16-29 production structures installed landward of the 800-m isobath will be removed using explosives as a result of a proposed action in the CPA. Likewise, 5-7 production structures installed landward of the 800-m isobath as a result of a proposed action in the WPA are likely to be removed using explosives.

OCS Program Scenario: The number of structures to be removed in the next several decades is expected to exceed the number of production structures installed (Pulsipher et al., 2001). Explosive removals will disturb the environment as explosives generate an unnatural pressure wave and noise. It is estimated that 629-783 production structures installed landward of the 800-m isobath in the WPA will be removed using explosives during 2003-2042. The number of production structures installed landward of the 800-m isobath in the CPA to be removed using explosives during the interval of 2003-2042 is estimated at 3,676-4,183. Explosive removal will not be used in the EPA. An unknown number of well stubs and subsea structures may be removed using explosives; an estimate is not possible at this time.

4.1.1.4.2. Bottom Debris

Bottom debris is defined as material resting on the seabed (such as cable, tools, pipe, drums, anchors, and structural parts of platforms, as well as objects made of plastic, aluminum, wood, etc.) that are accidentally lost (e.g., during hurricanes) or tossed overboard from fixed or floating facilities. The maximum quantity of bottom debris per operation is estimated to be several tons. The MMS requires site clearance over a radius of 400 m, which is assumed to be the areal extent over which debris will fall.

Chapter 4.1.1.4.4 describes the requirements and guidelines for removing bottom debris and gear after structure decommissioning and removal operations. There are also requirements for verification that operational debris has been removed from the areas around the platform removal site (e.g., by trawling the area to verify that the site has, in fact, been cleared of debris).

The Fishermen's Contingency Fund (FCF) was established to provide recourse for recovery of commercial fishing equipment losses due to entanglement on OCS oil and gas structures and debris. In FY 99, a total of 28 claims were approved and a total of $173,433 was paid. In FY 2000, a total of 25 claims were approved and $187,436 was paid. In FY 2001, a total of 15 claims were approved and $120,293 was paid.

Proposed Action Scenario: Up to a few hundred tons of bottom debris are expected to result from activities associated with each proposed action. It is assumed that most of this debris will be removed from the seafloor during the structure decommissioning and removal process as a result of the MMS site clearance and verification requirements.

OCS Program Scenario: It is estimated that several hundred tons of bottom debris (both ferromagnetic and nonferromagnetic) have been deposited on the seafloor as a result of prior OCS oil and gas activity. Oil and gas activities on the Gulf of Mexico OCS over the next 40 years will likely add several thousand tons of bottom debris on the seafloor. It is assumed that most of the future lost or tossed debris will be removed from the seafloor during the structure decommissioning, site clearance, and verification process.

4.1.2. Coastal Impact-Producing Factors and Scenario

4.1.2.1. Coastal Infrastructure

4.1.2.1.1. Service Bases

The proposed actions are expected to impact only those ports that currently have facilities needed for use by the oil and gas industry as offshore service bases. A service base is a community of businesses that load, store and supply equipment, supplies and personnel that are needed at offshore work sites. Although a service base may primarily serve the OCS planning area and coastal Subarea in which it is located, it may also provide significant services for the other OCS planning areas and coastal Subareas. Table 3-33 shows the 50 services bases the OCS currently uses. These facilities were identified as the primary service base by platform plans received by MMS. Based on numbers provided by Offshore Data Services, the ports of Fourchon, Cameron, Venice, and Morgan City, Louisiana, are the primary service bases for Gulf of Mexico mobile rigs. Major platform service bases are Galveston, Freeport, and Port O'Connor, Texas; Cameron, Fourchon, Intracoastal City, Morgan City, and Venice, Louisiana; Pascagoula, Mississippi; and Theodore, Alabama.

As the industry continues to evolve so do the requirements of the onshore support network. With advancements in technology, the shore-side supply network will continue to be challenged to meet the needs and requirements of the industry. All supplies must be transported from land-based facilities to marine vessels or helicopters to reach offshore destinations. This utilizes both water and air transportation modes. The intermodal nature of the entire operation gives ports (which traditionally have water, rail, and highway access) a natural advantage as an ideal location for onshore activities and intermodal transfer points. Therefore, ports will continue to be a vital factor in the total process and must incorporate the needs of the offshore oil and gas industry into their planning and development efforts particularly with regard to determining their future investment needs. In this manner both technical and economic determinants must influence the dynamics of port development.

Issues and concerns that must be addressed at the local level have resulted from the significant prosperity that has followed the industry. These extend beyond specific port needs into the community itself. Most of these problems can be nullified with additional infrastructure. However, additional infrastructure is difficult to develop. It is expensive to construct and requires substantial planning and construction time prior to completion. Rapidly developing technology has resulted in changing needs for the offshore oil and gas industry. This has placed a burden on the ports to provide the necessary infrastructure and support facilities required to meet the needs of the industry in a timely manner.

To continue to offer a viable service and to stay current with technological trends and industry standards, ports must be able to incorporate offshore oil and gas industry information into their planning for future infrastructure development, staffing needs, and other impacts associated with rapid industrial growth. Expansion of some existing service bases is expected to occur to capture and accommodate the current and future oil and gas business that is generated by development on the OCS and State waters. Some channels in and around the service bases will be deepened and expanded in support of deeper draft vessels and other port activities, some of which will be OCS related.

As OCS operations have progressively moved into deeper waters, larger vessels with deeper drafts have been phased into service, mainly for their greater range, faster speed, and larger carrying capacity. Services bases with the greatest appeal for deepwater activity have several common characteristics: strong and reliable transportation systems; adequate depth and width of navigation channels; adequate port facilities; existing petroleum industry support infrastructure; location central to OCS deepwater activities; adequate worker population within commuting distance; and insightful strong leadership. Typically, deeper draft service vessels require channels with depths of 6-8 m.

Proposed Action Scenario: A proposed action in the CPA or WPA will not change identified service bases or require any additional service bases.

OCS Program Scenario: The OCS Program activities will continue to lead to a consolidation of port activities at specific ports especially with respect to deepwater activities (i.e., Port Fourchon and Galveston). The OCS Program will require no additional service bases.

4.1.2.1.2. Helicopter Hubs

Helicopter hubs or "heliports" are facilities where helicopters can land, load, and offload passengers and supplies, refuel, and be serviced. These hubs are used primarily as flight support bases to service the offshore oil and gas industry. Most of the helicopter trips originate at helicopter hubs in coastal Texas and Louisiana. There are 128 heliports in the analysis area that support OCS activities. Three helicopter companies dominate the Gulf of Mexico offshore helicopter industry: Air Logistics, Era Aviation, and Petroleum Helicopters, Inc. A few major oil companies operate and maintain their own fleets, although this is a decreasing trend. Instead of running their own fleets, oil and gas companies are increasingly sub-contracting the whole operation on a turnkey basis to independent contractors. More and more operations are outsourcing to oil-field support companies, such as Baker Hughes, who are much more cost conscious and skeptical about the high cost of helicopters. Another consideration for the helicopter industry is new technology such as subsea systems. These systems decrease the number of platforms and personnel needed offshore, therefore reducing the amount of transportation needed.

To meet the demands of deep water (travel farther and faster, carry more personnel, be all-weather capable, and have lower operating cost), the offshore helicopter industry is purchasing new helicopters. While some heliports located farther inland have closed or consolidated, some heliports are expanding or opening due to more of the industry's work being farther offshore.

Proposed Action Scenario: A range of 220,000-870,000 helicopter trips is projected to result from activities associated with a proposed action in the CPA. A range of 6,000-22,000 helicopter trips is projected to occur annually. A range of 110,000-410,000 helicopter trips is projected to result from activities associated with a proposed action in the WPA. A range of 3,000-10,000 helicopter trips is projected to occur annually.

OCS Progam Scenario: Minimal helicopter hub construction or closures are anticipated. While some heliports located farther inland have closed or consolidated, some heliports are expanding or opening due to more of the industry's work being farther offshore. No new heliports are projected as a result of the OCS Program, however they may expand at current locations. A range of 27,997,00-50,692,000 helicopter trips is projected to result from activities associated with the OCS Program. A range of 700,000-1,267,000 helicopter trips is projected to occur annually.

4.1.2.1.3. Construction Facilities

4.1.2.1.3.1. Platform Fabrication Yards

Given the platform fabrication industry characteristics and trends therein, it is not likely that new yards will emerge. The existing fabrication yards do not operate as "stand alone" businesses, rather they rely heavily on a dense network of suppliers of products and services. Also, since such a network has been historically evolving in Louisiana and Texas for over 50 years, the existing fabrication yards possess a compelling force of economic concentration to prevent the emergence of new fabrication yards. There are 43 platform fabrication yards in the analysis area.

With respect to the deepwater development, the challenges for the fabrication industry stem from the greater technical sophistication and the increased project complexity of the deepwater structures, such as compliant towers and floating structures. The needs of the deepwater projects are likely to result in two important trends for the fabrication industry. The first is the increasing concentration in the industry, at least with respect to the deepwater projects. As technical and organizational challenges continue to mount up, it is expected that not every fabrication yard will find adequate resources to keep pace with the demands of the oil and gas industry. The second trend is the closer integration—through alliances, amalgamations, or mergers—among the fabrication yards and engineering firms.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: No new facilities are expected to be constructed in support of OCS Program activities. Some current yards may close, be bought out, or merge over the 2003-2042 period resulting in fewer active yards in the analysis area.

4.1.2.1.3.2. Shipyards

The 1980's were dismal for the shipbuilding industry. Several mergers, acquisitions, and closings occurred during the downturn. Of those that have remained, 94 are located with in the analysis area (Table 4-8). Several large companies dominate the oil and gas shipbuilding industry. Most yards in the analysis area are small. To a great extent, growth will be based on a successful resolution of several pertinent issues that have affected and will continue to affect shipbuilding in the U.S. and particularly in the analysis area: maritime policy, declining military budget, foreign subsidies, USCG regulations, OPA 90, financing, and an aging fleet.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: No new facilities are expected to be constructed in support of OCS Program activities. Some current yards may close, be bought out, or merge over the 2003-2042 period, which would result in fewer active yards in the analysis area.

4.1.2.1.3.3. Pipecoating Facilities and Yards

There are currently 19 pipecoating plants in the analysis area (Table 4-8). Pipe-coating facilities receive manufactured pipe, which they then coat the surfaces of with metallic, inorganic, and organic materials to protect from corrosion and abrasion and to add weight to counteract the water's buoyancy. Two to four sections of pipe are then welded at the plant into 40-ft segments. The coated pipe is stored (stacked) at the pipeyard until it is needed offshore.

To meet deepwater demand, pipecoating companies have been expanding capacity or building new plants. A new trend in the industry is single-source contracts where the pipe manufacturing, coating, welding and laying are all under one contract. This results in a more efficient, less costly operation. At present, though, only foreign companies have this capability.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: Current capacity, supplemented by recently built plants and expansions, are anticipated to meet OCS Program demand. No new facilities are expected to be constructed in support of OCS Program activities.

4.1.2.1.4. Processing Facilities

4.1.2.1.4.1. Refineries

A refinery is an organized arrangement of manufacturing units designed to produce physical and chemical changes to turn crude oil into petroleum products. In the refinery, most of the nonhydrocarbon substances are removed from crude oil and it is broken down into its various components, and blended into useful products.

In the early 1980's, the Crude Oil Entitlements Program ended and crude oil prices were no longer controlled. This caused the number of petroleum refineries to drop sharply leading to 13 years of decline in U.S. refining capacity. The decade of the 1990's was characterized by low product margins and low profitability. Refining operations consolidated, the capacity of existing facilities expanded, and several refineries closed. Most refineries are part of major, vertically integrated oil companies that are engaged in both upstream and downstream aspects of the petroleum industry. These companies dominate the refining industry, although most majors are spinning off their refinery facilities to independents or entering joint ventures to decrease the risk associated with low refining returns. The analysis area hosts over one-third of the petroleum refineries in the U.S. Most of the region's refineries are located in Texas and Louisiana (Table 4-8) representing 55.04 and 38.49 percent, respectively, of total U.S. refining capacity.

Two significant environmental considerations facing U.S. refiners are Phase 2 Clean Air Act Amendments (CAAA) of 1990 reformulated motor gasoline (RFG) requirements and the growing public opposition to the use of methyl tertiary butyl ether (MTBE). In order to meet Phase 2 RFG requirements, U.S. refiners will incur numerous expenses and make substantial investments. The MTBE is an additive that increases the oxygen content of motor gasoline causing more complete combustion of the fuel and less pollution. It was a relative inexpensive way for refiners to meet Phase 1 CAAA RFG requirements. Since March 1999, eight states have adopted bans on the use of MTBE because of concerns about groundwater contamination. This will cause additional outlays of money and some restructuring of current facilities in order to move to ethanol.

Distillation capacity is projected to grow from the 1998 year-end level of 16.3 million barrels per day to between 17.6 million and 18.3 million in 2020. Almost all the capacity additions are projected to occur on the Gulf Coast. Financial, environmental, and legal considerations make it unlikely that new refineries will be built in the United States; therefore, expansion at existing refineries likely will increase total U.S. refining capacity in the long-run. Refineries will continue to be utilized intensively, in a range from 93 to 96 percent of design capacity.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: No new facilities are expected to be constructed in support of OCS Program activities. While financial, environmental, and legal considerations make it unlikely that new refineries will be built in the U.S., expansion at existing refineries likely will increase total U.S. refining capacity over the 2003-2042 period.

4.1.2.1.4.2. Gas Processing Plants

After raw gas is brought to the earth's surface, it is processed at a gas processing plant to remove impurities such as water, carbon dioxide, sulfur, and inert gases and transformed into a saleable, useable energy source. The total number of natural gas processing plants operating throughout the U.S. has been declining over the past several years as companies have merged, exchanged assets, and closed older, less efficient plants. However, this trend was reversed in 1999. Louisiana, Mississippi, and Alabama's capacity is undergoing significant increases as a wave of new plants and expansions try to anticipate the increased coming ashore from new gas developments in the Gulf of Mexico. At present, there are 35 gas processing plants in the analysis area that process OCS gas (Table 4-8).

According to a study published by the Gas Research Institute, offshore Gulf of Mexico is the only area of the U.S. that offers potential new gas supplies for gatherers/processors. This is also the only region where any significant exploration is occurring. The MMS anticipates the construction of as many 4-16 new gas-processing plants in the analysis area to process OCS gas (Table 4-8). Of these new plants, 1-5 are expected to be located in Texas, 3-9 in Louisiana, and 0-2 in the Mississippi-Alabama area.

Proposed Action Scenario: No new facilities are expected to be constructed as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: Due to the potential for gas in the Gulf of Mexico OCS, MMS anticipates 4-16 new gas processing plants will be constructed in the analysis area in support of OCS Program activities.

4.1.2.1.5. Terminals

4.1.2.1.5.1. Pipeline Shore Facilities

The term “pipeline shore facility” is a broad term describing the onshore location where the first stage of processing occurs for OCS pipelines carrying different combinations of oil, condensate, gas, and produced water. Pipelines carrying only dry gas do not require pipeline shore facilities; the dry gas is piped directly to the gas processing plant (Chapter 4.1.2.1.4.2). Some processing may occur offshore at the platform; only onshore facilities are addressed in this section.

Pipeline shore facilities may separate, process, pump, meter, and store oil, water, and gas depending on the quality of the resource carried by the pipeline. After processing and metering, the liquids are either piped or barged to refineries or storage facilities. The gas is piped to a gas processing plant for further refinement, if necessary; otherwise, it is transported via transmission lines for distribution to commercial consumers. Water that has been separated out is usually disposed into on-site injection wells.

A pipeline shore facility may support one or several pipelines. Typical facilities occupy 2-25 ha. Although older facilities may be located in wetlands, current permitting programs prohibit or discourage companies from constructing any new facilities in wetlands. As a result of the OCS Program, new shore facilities may be needed to support new pipeline landfalls (see the table below). It is projected that CPA and WPA proposed actions would represent 2 and 1 percent, respectively, of the resources handled by these shore facilities.

Projected Pipeline Shore Facilities for the OCS Program (2003-2042) by Coastal Subareas

TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	FL-1	Total
0-1	2-4	2-3	3-5	3-4	2-3	0	12-20

4.1.2.1.5.2. Barge Terminals

Eight barge terminals along the Gulf Coast are currently being used by the OCS oil industry (Chapter 3.3.3.8.6). These facilities usually have some storage capabilities and processing facilities. Some barge terminals may also serve as pipeline shore facilities.

Of the four barge terminals in Louisiana, three receive oil from only CPA leases and one receives oil from both WPA and CPA leases. Of the four barge terminals in Texas, three receive oil from only WPA leases and one receives oil from only CPA leases. These barge terminals may also receive oil from State production or imports. Texas terminals receive approximately 30 percent of OCS barged oil and Louisiana terminals receive approximately 70 percent.

Barging of OCS production is expected to remain stable. No major modifications or new barge terminals are expected to be constructed in the foreseeable future to support proposed-action or OCS-Program operations. Chapter 4.1.1.3.8.2 discusses OCS barging operations in general.

4.1.2.1.5.3. Tanker Port Areas

The transport of OCS-produced oil from FPSO operations to inside or shore-side facilities would be accomplished with shuttle tankers rather than oil pipelines. The following tanker ports were identified in Chapter 3.3.3.8.6 as destinations for shuttle tankers transporting crude oil from FPSO operations in the Gulf of Mexico: Corpus Christi, Freeport, Port Arthur/Beaumont, and Houston/Galveston, Texas; and Lake Charles, the lower Mississippi River ports (Baton Rouge, Port of South Louisiana, New Orleans, and Plaquemines), and the Louisiana Offshore Oil Port, Louisiana. These ports were selected based on their location to refineries and channel depth.

The number of shuttle-tanker trips to port in a given year is primarily a function of the FPSO production rate and the capacity of supporting shuttle tankers. Considering an FPSO operating at a peak production rate of 150,000 bbl/day, supported by shuttle tankers of 500,000 bbl capacity, offloading would occur once every 3.3 days. This would equate to 54.75 million bbl of production with 110 offloading events and shuttle-tanker transits to Gulf coastal or offshore ports annually.

Proposed Action Scenario: Chapter 4.1.1.3.8.3 estimated that no tanker transport of OCS-produced oil will occur as a result of a single proposed action in the CPA or WPA. An FPSO and associated tankering is assumed to support production from leases resulting from multiple sales; any one proposed action is expected to contribute incrementally to tankering under the OCS Program. Therefore, there will be no additional traffic through tanker ports with respect to the proposed actions.

OCS Program Scenario: Chapter 4.1.1.3.8.3 developed a scenario for future OCS oil transportation by shuttle tanker. These assumptions resulted in an estimate that 0-6 percent of oil from the OCS Program will be tankered in water depths greater than 200 m in the CPA and WPA. It is projected that 500-1,000 offloading operations and shuttle-tanker transits will occur annually from OCS Program activities during the peak years of FPSO use in the CPA and WPA. There will be no tankering in the EPA. Texas tankering ports will probably receive less than 1 percent of oil production, while each Louisiana tanker port may receive 1-2 percent. Table 4-12 shows the minimum and maximum number of new tanker port trips per year under seven different port options with the most likely option mirroring current tanker traffic activities. As can be seen in Table 3-30, tanker trips associated with OCS Programs activities would represent a small percentage of annual tanker trips into identified tanker ports.

4.1.2.1.6. Disposal and Storage Facilities for Offshore Operational Wastes

Both the Gulf of Mexico offshore oil and gas industry and the oil and gas waste management industry are undergoing significant changes. New drilling technologies and policy decisions as well as higher energy prices should increase the level of OCS activity and, with it, the volumes of waste generated. The oil-field waste industry, having been mired in somewhat stagnant conditions for almost two decades, has developed new increments of capacity, and some new entrants into the market have added to industry capacity and the diversity of technologies available for the industry to use.

Facilities that accept OCS-generated waste that is not unique to oil and gas operations, such as municipal waste landfills and hazardous waste treatment, storage and disposal facilities, are diverse and specialized and manage waste for the broad base of U.S. industry. The OCS activity does not generate a large part of the waste stream into these facilities and is not expected to be material to the overall capacity of the industry. Capacity of industrial waste management facilities is for the most part abundant, as U.S. industries have learned to minimize wastes they ship to offsite facilities for management.

Proposed Action Scenario: No new disposal and storage facilities will be built as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: No new disposal and storage facilities are expected to be constructed in support of OCS Program activities.

4.1.2.1.6.1. Nonhazardous Oil-field Waste Sites

Long-term capacity to install subsurface injection facilities onshore is itself not scarce and oilfield waste injection well permits do not generally attract much public opposition. With the volume of produced water frequently exceeding the volume of oil a well produces by tenfold or more, the main limitation to widespread use of land-based subsurface injection facilities is the space at docks and the traffic in and out of ports.

With the addition of Trinity Field Services to the market this year, the OCS market has its first salt dome disposal operation in a competitive location, with 6.2 million barrels of space available initially. This is enough capacity to take 8-10 year’s worth of OCS liquids and sludges at current generation rates and a potential of several times that amount with additional solution mining. Salt domes are well-known and well-documented geological structures, and others could be placed into service as demand dictates. Salt caverns are a finite resource, but nevertheless have the potential to take decades’ worth of OCS offsite NOW generation.

Proposed Action Scenario: No new NOW waste sites will be built as a result of a proposed action in the CPA or WPA. Capacity to manage waste generated by a proposed action’s drilling and production activities is adequate for the present.

OCS Program Scenario: No new NOW waste sites will be built as a result of the OCS Program. Oil and gas waste management facilities along the Gulf of Mexico coast have adequate capacity and for a hypothetical future that includes a doubling of current waste volumes.

4.1.2.1.6.2. Landfills

The use of landfarming of OCS waste is likely to decline further, particularly with greater availability of injection methods for wastes containing solids. Future regulatory efforts are likely to discourage the practice by adding requirements that damage the economics if not by an outright ban on future permits.

Even though growth in OCS waste volumes can be expected to follow a linear relationship with increased OCS drilling and production activity, landfills will continue to be a small factor in the reduction of trash generated by OCS activity. Assuming a landfill (1) presently had OCS waste constituting 5 percent of its waste stream, (2) the remaining life of a landfill was 20 years at current fill rates, and (3) OCS waste doubled but the rest of the incoming waste stream remained flat, then the OCS activities would cause the landfill to be close at the end of 19 years as a result of the OCS contribution increase. With no waste received from OCS activities at all, the landfill would close in 21 years.

Proposed Action Scenario: No new landfills will be built as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: No new landfill waste sites will be built as a result of the OCS Program. Landfills are a small factor in the reduction of trash generated by OCS activity.

4.1.2.1.7. Coastal Pipelines

This section discusses OCS pipelines in coastal waters (State offshore and inland waters) and coastal onshore areas. See Chapter 4.1.1.3.8.1 for a discussion of pipelines in Federal offshore waters. The OCS pipelines near shore and onshore may join pipelines carrying production from State waters or territories for transport to processing facilities or to distribution pipelines located farther inland. See Chapter 4.1.3.1.2 for a discussion of pipelines supporting State oil and gas production.

Nearly 400 OCS pipelines cross the Federal/State boundary into State waters. There are nearly 1,700 km of OCS pipelines in State waters, with an average of 5 km per pipeline. Over half of the pipelines in State waters are directly the results of the OCS Program.

Pipelines in coastal waters may present a hazard to commercial fishing where bottom-trawling nets are used; this is one reason that pipelines must be buried in waters less than 200 ft. Pipeline burial is also intended to reduce the movement of pipelines by high currents and storms, to protect the pipeline from the external damage that could result from anchors and fishing gear, and to minimize interference with the operations of other users of the OCS. For the nearshore sections of OCS pipelines, COE and State permits for constructing pipelines require that turbidity impacts to submerged vegetation be mitigated through the use of turbidity screens and other turbidity reduction or confinement equipment.

Where a pipeline crosses the shoreline is referred to as a pipeline landfall. Gulfwide, two-thirds of OCS pipelines entering State waters tie into existing pipeline systems and do not result in new pipeline landfalls. Because of the extensive trunklines that parallel the Texas coastline, this ratio is lower in Texas. About 85 percent of OCS pipeline landfalls are in Louisiana. The oldest pipeline systems are also in Louisiana, with some dating back to the 1950's. The OCS pipelines making landfall have resulted in 700 km of pipelines onshore, with an average of 10 km per pipeline. A small percentage of onshore pipelines in the coastal subareas are directly the results of the OCS Program.

Recently, the trend is for new OCS pipelines to tie into existing systems rather than creating new landfalls. Over the last 10 years, there has been an average of two new OCS pipeline landfalls per year. As a mitigation measure to avoid adverse effects of barrier beaches and wetlands, most pipeline landfalls crossing barrier beaches and wetlands will be directionally bored under them.

About 16 percent of OCS pipelines making landfall are inactive or abandoned; some of these may have been or will be reactivated for OCS-related use. Pipelines may be abandoned in place if they do not constitute a hazard to navigation and commercial fishing or unduly interfere with other uses of the OCS.

Preliminary results from the MMS/USGS National Wetland Research Center's (NWRC) current study of coastal wetland impacts from pipeline construction and associated widening of canals utilizing USGS habitat data are summarized below (Johnston and Barras, personal communication, 2002):

> Approximately 15,400 km (9,570 mi) of OCS pipelines have been constructed in Louisiana from the 3-mi State/Federal boundary to the CZM boundary. Of those pipelines, approximately 8,000 km (4,971 mi) crossed wetland (marsh) or upland habitat. The remaining 7,400 km (4,598 mi) crossed waterbodies. Sources of OCS pipeline data

were Penn Well Mapsearch, MMS, National Pipeline Mapping System, and the Geological Survey of Louisiana pipeline datasets. Additionally, based on USGS 1978 habitat data, approximately 56 percent of the length of pipelines crossed marsh habitat and 44 percent crossed upland habitat. Using USGS landloss data from 1956 to 2002 within a 300-m (984-ft) buffer zone (150 m (492 ft) on each side of the pipeline), the total amount of landloss attributed to OCS pipelines was 34,400 ha (85,968 ac). This number represents 0.04 km^2 (4.00 ha, 9.88 ac) per linear km of pipeline installed. When one divides 34,400 ha by the 46-year period (1956-2002), the loss per year is 746 ha (1,843 ac) for the 8,000 km (4,971 mi) of OCS pipeline. This represents 11.9 percent of the total landloss in the Louisiana pipeline study area. Note that from the period 1990-2002 (based on the preliminary data by USGS), the total landloss due to pipelines for the study area was approximately 25 km^2 (~10 mi^2) or 525 ac/yr, which represents a dramatic decline from the 1956-1978 and 1978-1990 analysis periods (Table 4-64). Many of these pipelines were installed prior to the implementation of the NEPA of 1969 and the State of Louisiana's Coastal Permit Program in 1981. Additionally, given the width of the buffer, 300 m (984 ft) versus actual pipeline-canal width, which may be 31-61 m (100-200 ft) wide, an unknown portion of the increase in open water is attributed to other factors unrelated to OCS pipelines. To address this, selected OCS pipelines are being studied in greater detail to ascertain direct and secondary impacts to the extent possible and the information from that analysis will be included in future NEPA documents.

Technologies have been and continue to be developed that decrease the impacts of OCS pipelines on wetlands and associated sensitive habitat. For example, the proposed 30-in Endymion pipeline would deliver crude oil from South Pass Block 89 to the LOOP storage facility near the Clovelly Oil and Gas Field. Based on a review of the data in the COE permit application (No. 20-020-1632), the pipeline construction would have zero (0) impacts to marshes (emergent wetlands) and beaches because the operator is using horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Additionally, the proposed route traverses open water to the extent possible.

See Table 4-13 for projected coastal pipelines due to the proposed actions; for existing and projected coastal pipelines as a result of the OCS Program, see Table 4-14.

4.1.2.1.8. Coastal Barging

It is projected that of the percentage of OCS oil barged (<1%) from offshore platforms to shore bases will continue to be only a small portion of the total amount of oil barged in coastal waters. There is a tremendous amount of barging that occurs in the coastal waters of the Gulf of Mexico, and no estimates exist of the volume of this barging that is attributable to the OCS industry. Secondary barging of OCS oil often occurs between terminals or from terminals to refineries. Oil that is piped to shore facilities and terminals is often subsequently transported by barge up rivers, through the Gulf Intracoastal Waterway, or along the coast.

The current rate (<1%) of OCS barging is expected to continue and is not likely to make up a significantly larger percentage of the total oil barged than what is currently occurring.

4.1.2.1.9. Navigation Channels

The current system of navigation channels around the northern Gulf is believed to be generally adequate to accommodate traffic generated by a proposed action and the future OCS Program. Gulf-to-port channels and the Gulf of Mexico Intracoastal Waterway that support the prospective ports are sufficiently deep and wide enough to handle the additional traffic. As exploration and development activities increase on deepwater leases in the Gulf, vessels with generally deeper drafts and longer ranges will be used as needed to support deepwater activities. Therefore, several OCS-related port channels may be deepened or widened during the life of a proposed action to accommodate deeper draft vessels. Typically, no channel deeper than 8 m will be needed to accommodate these deeper draft vessels.

Proposed Action Scenario: Current navigation channels will not change as a result of a proposed action in the CPA or WPA. In addition, no new navigation channels will be required by a proposed action in the CPA or WPA.

OCS Program Scenario: A few OCS-related port channels may be deepened or widened during the 2003-2042 period to accommodate deeper draft vessels necessary for deepwater development. The OCS Program will require no new navigation channels.

4.1.2.1.10. Discharges and Wastes

4.1.2.1.10.1. Onshore Facility Discharges

The primary onshore facilities that support offshore oil and gas activities include service bases, helicopter hubs at local ports/service bases, construction facilities (platform fabrication yards, pipeyards, shipyards), processing facilities (refineries, gas processing plants, petrochemical plants), and terminals (pipeline shore facilities, barge terminals, tanker port areas). A detailed description of these facilities is given in Chapter 3.3.3.8. Discharges from these facilities can be divided into point sources and nonpoint sources. The USEPA regulates point-source discharges as part of the National Pollution Discharge Elimination System (NPDES). Facilities are issued individual permits that limit discharges specific to the facility type and the waterbody receiving the discharge. The USEPA is currently assessing methods of regulating nonpoint-source discharges, which are primarily run-off from facilities. Other wastes generated at these facilities are handled by local municipal and solid waste facilities, which are also regulated by USEPA.

4.1.2.1.10.2. Coastal Service-Vessel Discharges

Operational discharges from vessels include sanitary and domestic water, bilge waters, and ballast waters. Support-vessel operators servicing the OCS industry offshore may still legally discharge oily bilge waters in coastal waters, but they must treat the bilge water to limit its oil content to 15 parts per million prior to discharge. Sanitary wastes are treated on-board ship prior to discharge. State and local governments regulate domestic or gray water discharges.

4.1.2.1.10.3. Offshore Wastes Disposed Onshore

All wastes that are not permitted to be discharged offshore by the USEPA must be transported to shore via service vessels or reinjected downhole. Drilling muds and cuttings from operations that use oil-based drilling fluids (OBF) or synthetic-based drilling fluids (SBF) cannot be discharged offshore. The USEPA Region 4 also does not permit the discharge of cuttings wetted with SBF. Drill cuttings contaminated with hydrocarbons from the reservoir fluid must also be disposed of onshore. Prior to 1993, an estimated 12 percent of drilling fluids and 2 percent of cuttings failed NPDES compliance criteria and were required to be reinjected or brought to shore for disposal (USEPA, 1993a and b); these pre-1993 percentages are based on data related to the use of OBF. More recent data is not available; however, the increased use of SBF and the discharge of the derived cuttings may result in a decrease in drilling waste brought to shore. Regular supply boats can carry 10 cutting boxes on deck and store 2,500 bbl of fluids in tanks below deck; dedicated supply boats carry 16 cutting boxes and can store 2,500 bbl of fluids below deck (USEPA, 1993a and b).

The USEPA allows treatment, workover, and completions (TWC) fluids to be commingled with the produced-water stream if the combined produced-water/TWC discharges pass the toxicity test requirements of the NPDES permit. Facilities with less than 10 producing wells may not have enough produced water to be able to effectively commingle the TWC fluids with the produced-water stream (USEPA, 1993a and b). Analysis of the MMS database shows that about 73 percent of all platform complexes have less than 10 well slots and therefore must bring their waste to shore. Spent TWC fluid is stored in tanks on tending workboats or is stored on platforms and later transported to shore on supply boats or workboats. Once onshore, the TWC wastes are transferred to commercial waste-treatment facility barges and disposed of down commercial disposal wells. Offshore wells are projected to generate an average volume of 200 bbl from either a well treatment or workover job every 4 years. Each new well completion will generate about 150 bbl of completion fluid.

Current USEPA NPDES general permits prohibit operators in the Gulf of Mexico from discharging any produced sands offshore. Cutting boxes (15- to 25-bbl capacities), 55-gallon steel drums, and cone-bottom portable tanks are used to transport the solids to shore via offshore service vessels. Total produced sand from a typical platform is estimated to be 0-35 bbl/day (USEPA, 1993a and b).

4.1.2.1.10.4. Beached Trash and Debris

Trash lost overboard from OCS platforms and support activities can wash ashore on Gulf coastal lands, reducing their attractiveness. However, according to The Ocean Conservancy (formerly The Center for Marine Conservation), beach-goers are a prime source of beach pollution, leaving behind nearly 75 tons of trash per week. Millions of annual visitors attracted to the coast are responsible in large part for the trash and debris that litter coastal lands. Other sources of coastal trash are runoff from storm drains and antiquated storm and sewage systems in older cities. Such systems allow co-mingling and overflows of raw sewage and industrial waste into nearby rivers and coastal areas. Also involved in production of trash and debris are commercial and recreational fishers who discard plastics (for example, ropes, buoys, fishing line and nets, strapping bands, and sheeting), wood, and metal traps.

The Ocean Conservancy sponsors a national marine-debris monitoring program. Data from these efforts in the Gulf of Mexico coastal area are shown in Table 4-15. The cleanup activities take place on all beaches—river, lake, and sea—and adjacent waters. The table indicates the quantities of trash and the location, but it does not indicate the assumed or suspected source of the debris.

Some trash items, such as glass, pieces of steel, and drums with chemical or chemical residues, can also be a health threat to local water supplies, to beachfront residents, and to users of recreational beaches. Cleanup of OCS trash and debris from coastal beaches adds to operation and maintenance costs for coastal beach and park administrators.

4.1.2.1.11. Noise

Coastal noise associated with OCS oil and gas development results from helicopter and service-vessel traffic. Sound generated from these activities can be transmitted through both air and water, and may be continuous or transient. The intensity and frequency of the noise emissions are highly variable, both between and among these sources. The level of underwater sound detected depends on receiver depth and aspect, and the strength/frequencies of the noise source. The duration that a passing airborne or surface sound source can be received underwater may be increased in shallow water by multiple reflections (echoes).

Service vessels and helicopters (discussed also in Chapters 4.1.1.3.8.4 and 4.1.1.3.8.5) may add noise to broad areas. Sound generated from helicopter and service-vessel traffic is transient in nature and extremely variable in intensity.

Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hz (Richardson et al., 1995). Helicopters often radiate more sound forward than backward, and the underwater noise is generally brief in duration, compared with the duration of audibility in the air. Water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. Lateral propagation of sound is greater in shallow than in deep water. Helicopters, while flying offshore, generally maintain altitudes above 700 ft during transit to and from the working area. A range of 6,000-22,000 helicopter trips is projected to occur annually as a result of a proposed action in the CPA. A range of 3,000-10,000 helicopter trips is projected to occur annually as a result of a proposed action in the WPA.

Service vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion; other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake (Richardson et al., 1995). Propeller cavitation is usually the dominant noise source. The intensity of noise from service vessels is roughly related to ship size and speed. Sounds from support boats range from 400 to 7,000 Hz at 120-160 dB (USDOC, NMFS, 1984). Large ships tend to be noisier than small ones, and ships underway with a full load (or towing or pushing a load) produce more noise than unladen vessels. Noise increases with ship speed; ship speeds are often reduced in restricted coastal waters and navigation channels. A range 2,000 - 3,000 service-vessel trips is projected to occur annually as a result of a proposed action in the CPA.

About 1,000 service-vessel trips are projected to occur annually as a result of a proposed action in the WPA.

4.1.3. Other Cumulative Activities Scenario

4.1.3.1. State Oil and Gas Activities

4.1.3.1.1. Leasing and Production

Texas

The Lands and Minerals Division of the Texas General Land Office holds quarterly lease sales on the first Tuesday in January, April, July, and October of each year. Prior to July 1999, biannual sales were held.

The Texas coast is the largest along the Gulf of Mexico, spanning 400 mi and encompassing 12 counties. Texas also has the largest legal area of land extending Gulfward. Initially all coastal states owned 3 mi of land into the Gulf of Mexico; however, with the enactment of the Submerged Lands Act and its interpretation by the Supreme Court in 1960, Texas land extends 3 marine leagues (10.4 mi). The State of Texas has authority over and owns the water, beds, and shores of the Gulf of Mexico equaling nearly 2.5 million ac.

The growth of the oil industry in the 20th century helped reform the State's land policy from an emphasis on income through the sale of land to an emphasis on income through resource management and development. The Texas General Land Office is directly responsible for the management of more than 22 million acres of land that remains in the public domain. According to the Relinquishment Act of 1919, a surface owner acts as leasing agent for the State on privately owned land where the State retains the mineral rights, and the State and surface owner share rentals, royalties, and bonuses.

The Texas Land Commissioner is authorized to lease designated public land for oil and gas production and it now accounts for most of the income derived from public land. The State receives revenues from royalties, rentals, and bonuses. In addition to being leased for mineral production, land is leased for hunting, grazing, fishing, and commercial development. Land trades, experimental projects and in-kind gas sales also provide revenue for the State. The Railroad Commission of Texas is the agency charged by the Texas Legislature with the regulation of the oil and gas industry in the State of Texas. The Commission's primary regulatory responsibilities are protecting the correlative rights of the mineral interest owners, preventing the waste of otherwise recoverable natural resources, and protecting the environment from pollution by oil and gas exploration and production activities.

In recent years, oil and gas production in the State of Texas has been declining. From 1978 to 1998 annual crude oil production fell from 1,040,966 Mbbl to 457,499 Mbbl. However, in that same timeframe, the number of producing oil wells rose from 166,65 to 170,288. Natural gas production has shown a similar trend over the same period. From 1978 to 1998, Texas natural gas production fell from 7,077.1 tcf to 5,772.1 tcf and the number of producing gas wells rose from 33,157 to 58,436. Texas offshore oil and gas production for the year 2000 was 41,106 tcf of natural gas and 520,352 bbl of oil. Texas offshore oil and gas production for the year 2001 (as of May 2001) is 18,057 tcf of natural gas and 210,783 bbl of oil (Texas Railroad Commission, 2001).

Louisiana

The Office of Mineral Resources holds regularly scheduled lease sales on the second Wednesday of every month. The first oil production in commercial quantities occurred in 1901 and it marked the beginning of the industry in the State. The first over-water drilling in America occurred in 1910 in Caddo Lake near Shreveport. The State began its offshore history in 1947. The territorial waters of Louisiana extend Gulfward for 3 mi and its shoreline extends nearly 350 mi.

Louisiana, through its aggressive minerals management programs, became the nation's third leading producer of natural gas and the number four producer of crude oil in the country. When including the oil and gas production in the Gulf of Mexico, Louisiana becomes the second leading natural gas producer in the country and the third leading crude oil producer. There are 19 active refineries in the State of Louisiana, which accounts for 15 percent of the total refining capacity in the United States. There are thousands of miles of pipelines in the State carrying crude oil from the Gulf of Mexico to refineries in

Louisiana and other states, as well as carrying natural gas throughout the United States (Louisiana Mid-Continent Oil and Gas Association, 2001).

In 1999, Louisiana offshore production totaled 12.8 MMbbl of crude oil from about 554 offshore oil wells and 147.5 tcf of natural gas from about 177 natural gas wells. In the same year, 44,645 persons were employed in the oil and gas production industry; 28,898 persons in the chemical industry; 11,046 persons in the oil refining industry; and 693 persons in the oil pipeline industry (Louisiana Dept. of Natural Resources, 2001).

In fiscal year 1999-2000, $237,967,797 of royalties and $354,765,574 in severance tax were collected by the State on all oil and natural gas production taking place on State-owned lands and water bottoms (Louisiana Dept. of Natural Resources, 2001).

Mississippi

Mississippi's petroleum infrastructure includes four refineries and a moderately extensive network of crude oil, product, and liquefied petroleum gas pipelines. Mississippi ranks eleventh in the nation, including Federal offshore areas, in crude oil production with 54,000 bbl per day. A major propane supply hub is located at Hattiesburg, Mississippi, where the Dixie Pipeline has a network of terminals and storage facilities. Natural gas as a primary heating fuel is used by 41 percent of homeowners, followed by electricity that is used by about 31 percent (USDOE, EIA, 2001c).

The State of Mississippi only has an onshore oil and gas leasing program. In 1994 the State of Mississippi passed legislation allowing companies to enjoy substantial tax breaks based on the types of discovery involved and the methods they use. Those tax breaks range from a five-year exemption from the State’s 6 percent severance tax for new discoveries to a 50 percent reduction in the tax for using 3D technology to locate new oil and gas fields, or using enhanced recovery methods.

As a result of the incentive program, 84 new oil pools have received the exemption, 108 inactive wells have been brought back into production, 13 development wells have been drilled in existing fields, 34 enhanced wells have received exemption, and 14 have receive exemptions for using 3D technology (Sheffield, 2000).

Alabama

Alabama has no established schedule of lease sales. The limited number of tracts in State waters has resulted in the State not holding regularly scheduled lease sales. The last lease sale was held in 1997.

The territorial waters of Alabama extend Gulfward for 3 nmi and its shoreline extends nearly 52 mi. The first wells drilled for oil in the southeastern United States were drilled in Lawrence County in 1865, just six years after the first oil well was drilled in the United States. The first commercially marketed natural gas production in the southeastern United States occurred in the early 1900’s near Huntsville. In 1979, gas was first discovered by MOEPSI in the mouth of Mobile Bay.

Alabama owns oil, gas, and mineral interests on small upland tracts, submerged river bottoms, estuaries, bays, and in the 3-mi area offshore. Most significant economically are the natural gas reserves lying within the 3-mi offshore area of Mobile and Baldwin Counties. The Alabama State Oil and Gas Board was created after the oil discovery in 1944 in Choctaw County and is responsible for regulating the exploration and development of these natural resources. The discovery of Alabama’s giant Citronelle Field in Mobile County in 1955 focused national attention on the State’s oil and gas potential. Major discoveries of natural gas in the 1980’s led to the development of an array of natural gas reservoirs, and Alabama became a world leader in the development of coalbed methane gas as an energy resource. The Norphlet development, which started in November 1978, results in high production rates of Norphlet Formation gas. This gas is a hot, sour, high-pressure, corrosive mixture of methane, hydrogen sulfide, carbon dioxide, and free water.

Alabama has reaped tremendous financial benefits from the development of offshore mineral resources. Revenues include severance taxes, bonuses, royalties, and rentals. At present, Alabama is considered a major oil- and gas-producing state.

As of August 2001, a total of 69 test wells have been drilled in Alabama coastal waters. Forty of these wells were permitted to test the Norphlet Formation below a depth of 20,000 ft. The 2 earliest wells were drilled to test undifferentiated rocks of Cretaceous age and 27 wells have targeted shallow Miocene gas reservoirs generally at depths of less than 3,500 ft. Operators have experienced a high success rate in drilling wells in Alabama coastal waters. A total of 28 of the 40 Norphlet Formation wells drilled to date have tested gas, and 23 of the 27 Miocene wells drilled have tested gas. Sixteen gas fields have been established in the offshore region of the State, with 7 fields being productive from the Norphlet Formation and 9 fields being productive from sands of Miocene age (Alabama State Oil and Gas Board, 2001). Indigenous crude oil production totals 29,000 bbl per day, ranking Alabama 16th out of the 32 producing states and Federal offshore areas. The State's three refineries have a combined crude oil distillation capacity of 130,000 bbl per calendar day, while several crude oil, product, and liquefied petroleum gas pipelines pass through the State (USDOE, EIA, 2001c).

Production of gas from the State's coastal waters flows through 44 fixed structures and platforms and now exceeds 220 Bcf annually. This accounts for approximately 50 percent of the total gas production in Alabama, which now ranks as one of the top 10 gas-producing states in the nation. Production capabilities for individual wells range from a few million to more than 110 million cubic feet per day (Alabama State Oil and Gas Board, 2001).

Florida

The State of Florida has experienced very limited drilling in coastal waters. At present, a moratorium has stopped drilling activity in Florida State waters, and the State has no plans for lease sales in the future. At present, no drilling rigs are operating within the State.

4.1.3.1.2. Pipeline Infrastructure for Transporting State-Produced Oil and Gas

The pipeline network in the Gulf of Mexico states is extensive. Pipelines transport crude oil and natural gas from the wellhead to the processing plants and refineries. Pipelines transport natural gas from producing states such as Texas and Louisiana and to a lesser extent Mississippi and Alabama to utility companies, chemical companies, and other users throughout the nation. Pipelines are used to transport refined petroleum products such as gasoline and diesel from refineries in the Gulf of Mexico region to markets all over the country. Pipelines are also used to transport chemical products (Louisiana Mid-Continent Oil and Gas Association, 2001).

The natural gas pipeline network has grown substantially since 1990 nationwide. The increasing growth in natural gas demand over the past several years has led to an increase in the utilization of pipelines and has resulted in some pressure for expansion in several areas. In the Gulf of Mexico, after several consecutive years of extensive pipeline development, installation of additional offshore Gulf of Mexico pipeline capacity has slowed. In 1997 and 1998, 14 natural gas pipeline projects were completed and added a total of 6.4 Bcf per day of new pipeline capacity, most of which represented large-capacity pipelines connecting onshore facilities with developing offshore sites, particularly in the deepwater areas of the Gulf. During 1999-2000, eight significant projects were completed, adding 1.8 Bcf per day to the area's pipeline capacity. The majority of these projects were built primarily to improve gathering operations and to link new and expanding producing platforms in the Gulf with recently completed offshore mainlines directed to onshore facilities (USDOE, EIA, 2001d).

Texas

The pipeline industry is a vital part of the oil and gas industry in Texas. At present, there are 218,000 mi under permit that transport natural gas, crude oil, and refined products. Of this figure, 142,000 mi are permitted to transport natural gas, 40,000 mi are permitted to transport crude oil and about 36,000 mi are permitted to transport refined products. The Railroad Commission of Texas' Pipeline Safety Section has jurisdiction for most pipelines that transport natural gas, crude oil, and refined products across Texas.

Louisiana

As in Texas, the pipeline industry is a vital part of the oil and gas industry in Louisiana. There are about 25,000 mi of pipe moving natural gas through interstate pipeline and about 7,600 mi of pipelines carrying natural gas through intrastate pipelines to users within the State's boundaries. Another 3,450 mi of pipeline in Louisiana transport crude oil and crude oil products. There are thousands of miles of flow lines and gathering lines moving oil and gas from the wellhead to separating facilities while other pipelines transport chemical products with no petroleum base. Louisiana is home to the world's only offshore superport, Louisiana Offshore Oil Port (LOOP), which allows supertankers to unload crude oil away from shore so that it can be transported via pipeline to onshore terminals. The Henry Hub in Louisiana is a hub of pipelines and is the point where financial markets determine the value of natural gas (Louisiana Mid-Continent Oil and Gas Association, 2001).

Mississippi

Petroleum infrastructure in Mississippi includes a moderately extensive network of crude oil, product, and liquefied petroleum gas pipelines. A major propane supply hub is the Dixie Pipeline has a network of terminals and storage facilities. Major pipelines for crude oil are operated by EOTT Energy, Genesis, Hunt, Shell, Mid-Valley, Scurlock-Permian, and BP. Major pipelines for liquefied petroleum gas are operated by Dixie, Plantation, Enterprise BP Dixie, and Enterprise (USDOE, EIA, 2001c).

Alabama

Petroleum infrastructure in Alabama includes a somewhat extensive network of crude oil, product, and liquefied petroleum gas pipelines. Major pipelines for crude oil are operated by Hess, Hunt, Genesis, Citronelle-Mobile, and Miller. Major pipelines for liquefied petroleum gas are operated by Dixie and Enterprise (USDOE, EIA, 2001c).

Florida

Petroleum infrastructure in Florida includes a limited network of crude oil, product, and liquefied petroleum gas pipelines. Genesis and Sunniland operate major pipelines for crude oil. Enterprise operates major pipelines for liquefied petroleum gas (USDOE, EIA, 2001c).

4.1.3.2. Other Major Offshore Activities

4.1.3.2.1. Dredged Material Disposal

Dredged material is described at 33 CFR 324 as any material excavated or dredged from navigable waters of the United States. According to the USEPA, "virtually all ocean dumping occurring today is dredged material, sediments removed from the bottom of waterbodies in order to maintain navigation channels and berthing areas" (USEPA, 1996).

In response to the Marine Protection, Research, and Sanctuaries Act of 1972, as of February 1996, the USEPA finalized the designation of 27 dredged material disposal sites in the Gulf of Mexico. Another 12 sites in the Gulf were considered interim sites pending completion of baseline or trend assessment surveys and then the final designation or termination of use of these sites (40 CFR 228.14). Since then, one interim site was approved on a final basis (40 CFR 228.15). Of the 39 designated and interim sites , 11, 21, and 7 sites are located in the WPA, CPA, and EPA, respectively. These sites range in area from 0.5 mi^2 to 9 mi^2 and are all within 20 mi of shore.

The COE issues permits for ocean dumping using USEPA's environmental criteria. These permits are subject to USEPA's concurrence. Under the Clean Water Act, the USEPA requires testing of dredge material prior to its disposal to ensure there are no unacceptable adverse impacts to the marine environment.

According to the COE's Ocean Disposal Database (ODD) more than 635 million m^3 of dredged material were disposed in the Gulf of Mexico from 1976 to 1999, which is an average of 26 million m^3 per year (U.S. Dept. of the Army, COE, 2001b). The USEPA, COE, and other interested parties are working to identify appropriate uses for dredged material rather than disposing of the material offshore. These uses may include beach nourishment or wetland habitat development.

A discussion of dredging operations in inland coastal regions around the Gulf is presented in Chapter 4.1.3.3.2.

4.1.3.2.2. Nonenergy Minerals Program in the Gulf of Mexico

This section discusses the impacts of the acquisition of nonenergy minerals (sand, shale, and gravel) from Federal waters in the CPA and WPA. There are many submerged shoals located on the OCS that are expected to be long-term sources of sand (sand borrow sites) for coastal erosion management. This sand is needed because of the general diminishing supply of onshore and nearshore sand. The renourishment cycles for beaches or coastal areas require quantities of sand that are not currently available from State sources. The offshore sites are an environmentally preferable resource because OCS sands generally lie beyond the local wave base and the influence of the nearshore physical regime where long-term dredging can result in adverse changes to the local wave climate and the beach. In addition, the offshore sites could provide compatible sand for immediate/emergency repair of beach and coastal damage from severe coastal storms. The economics of dredging in deeper waters is improving as dredging technology improves.

Sand Resources Programs

The MMS's Office of International Activities and Marine Minerals (INTERMAR) has been developing and procuring contracts to provide needed environmental information regarding environmental management of OCS sand resources. The potential for exploitation of sand resources has grown rapidly in the last several years as similar resources in State waters are being depleted or polluted. Several OCS areas are being examined as possible sources of aggregate for construction purposes. At present, there are no sand leases in the Gulf of Mexico CPA and WPA.

In 1999, the Marine Minerals component of INTERMAR published a study entitled *Environmental Survey of Identified Sand Resource Areas Offshore Alabama* (Byrnes and Hammer, 1999). This survey provided (1) an assessment of the baseline benthic ecological conditions in and around the five previously-identified proposed borrow sites (Figure 4-5); (2) evaluated the benthic infauna resident in the five potential borrow sites and assessed the potential effects of offshore dredging activity on these organisms, including an analysis of the potential rate and success of recolonization; (3) developed a schedule of the best and worst times for offshore dredging with regard to transitory pelagic species; (4) evaluated the potential for modification to waves because of offshore dredging within the five proposed sand borrow areas; and (5) evaluated the impacts of offshore dredging and subsequent beach nourishment in terms of potential alteration of sediment transport patterns, sedimentary environments, and impacts to local shoreline processes. The information gathered during this study will likely be used should a decision be made to proceed with the preparation of an EA or an EIS in support of a negotiated agreement with the State of Alabama for access to Federal sand resources. The information gathered during the course of this study will also enable MMS to monitor and assess the potential impacts of offshore dredging activities and to identify ways that dredging operations can be conducted so as to minimize or preclude long-term adverse impacts to the environment.

Another study, *Synthesis of Hard Mineral Resources on the Florida Panhandle Shelf: Spatial Distribution and Subsurface Evaluation* (McBride, 1999), produced regional baseline information on the hard mineral resources, geologic framework, and long-term sediment dynamics of the Florida Panhandle Shelf (Mobile Bay, Alabama, to Choctawhatchee, Florida (Figure 4-6)). The study's objectives were to (1) quantify hard mineral resource deposits; (2) establish the regional three-dimensional architecture of hard mineral deposits; (3) produce seafloor elevation models; (4) determine patterns and processes of shelf sediment transport; (5) integrate seafloor elevation models with geologic data to establish form-process relationships; (6) disseminate research results; and (7) incorporate appropriate data on hard minerals into the LSU Coastal Studies Institute's Gulfwide Information System.

The *Wave Climate and Bottom Boundary Layer Dynamics with Implications for Offshore Sand Mining and Barrier Island Replenishment in South-Central Louisiana* (Stone, in preparation) study produced measurements of wave characteristics at two locations on Ship Shoal to validate a spectral wave propagation model (STWAVE). The objectives of the study were to (1) obtain direct field measurements of bottom boundary layer hydrodynamic processes and suspended sediment transport; and (2) obtain direct field measurements of temporally and spatially varying directional wave parameters at several locations on Ship Shoal.

Sand sources that are to be used on a continual, multiyear, multiuse basis may require biological/physical monitoring to ensure that long-term adverse impacts to the marine and coastal environment do not occur. However, there exists no standard approach or methodology for properly monitoring the effects of ongoing dredging operations. The ongoing INTERMAR study, *Design of a Monitoring Protocol/Plan for Environmentally Sound Management and Development of Federal Offshore Sand Borrow Areas Along the United States East and Gulf of Mexico Coasts*, will address those concerns and issues. In addition, extensive damage to a beach area as the result of a severe storm may necessitate that a sand borrow area be used prior to the completion of the environmental work needed to support decisions on conditions of lease agreements. Therefore, some form of "conditions of approval" or "stipulation(s)" might be necessary if leases are to be issued.

The objectives of the above study are as follows:

- to provide MMS with an appropriate and sound design for a physical/biological monitoring system to evaluate the near-term, long-term, and cumulative effects of using Federal sand borrow areas on the U.S. East and Gulf Coasts;
- to examine the feasibility and appropriateness of including Federal, State, and local authorities with an interest in the use of offshore Federal sand in a regional management concept for developing ways to assure and monitor the responsible, environmentally sound, long-term management of Federal offshore sand areas; and
- if, in Year 1 of the study, the study team determines that it is feasible and appropriate to manage Federal offshore sand resources on a regional basis, to develop detailed plans and fully identify the relevant parties by geographic area to meet the needs of Federal, State, and local interests to facilitate the environmentally acceptable and cost-effective near and long-term use of Federal sand borrow areas offshore the U.S. East and Gulf of Mexico coasts.

In many cases, physical and biological monitoring of borrow areas may be necessary to preclude adverse impacts to the marine environment. An appropriate "condition of approval" or "stipulation" to support a lease for these areas might be the monitoring of the biological and physical regime during operations to ensure that no adverse impacts are or will occur. The study outlined above would provide a blueprint for these monitoring operations. To date, proposed coastal erosion management projects have been examined on a case-by-case, project-specific basis. These resources must be managed on a long-term, system-wide basis in such a way as to ensure that environmental damage will not occur as a result of continual and prolonged use.

4.1.3.2.3. Marine Transportation

An extensive maritime industry exists in the northern Gulf of Mexico. Figure 3-11 showed the major ports and domestic waterways in the analysis area, while Tables 3-30 and 3-31 presented the 1999 channel depth, number of trips, and freight traffic of OCS-related waterways. Marine transportation within the analysis area should grow linearly based on historical freight traffic statistics given current conditions. Should any infrastructure changes occur, then the marine transportation would reflect these changes. For example, if a port in the analysis area (or outside the analysis area) deepened its channel or constructed new railroads or highways into the port area, then the number of trips and the volume of commodities into and out of the port would change accordingly. Or if a refinery near one of the ports were to close, then tanker traffic to that port may decrease.

Tanker imports and exports of crude and petroleum products into the Gulf of Mexico are projected to increase (USDOE, EIA, 2001a). In 2000, approximately 2.08 BBO of crude oil (38 percent of U.S. total) and 1.09 BBO of petroleum products (13 percent of U.S. total) moved through analysis area ports. By the year 2020, these volumes are projected to grow to 2.79 BBO of crude oil and 1.77 BBO of petroleum products. Crude oil will continue to be tankard into the Gulf of Mexico for refining from Alaska, California, and the Atlantic.

Proposed Action Scenario: Marine transportation is not expected to change as a result of a proposed action in the CPA or WPA.

OCS Program Scenario: The number of trips and volume of commodities into and out of analysis area ports are expected to grow linearly based on historical freight traffic statistics. OCS Program activities over the 2003-2042 period are not expected to change marine transportation.

4.1.3.2.4. Military Activities

The air space over the Gulf of Mexico is used extensively by the Department of Defense (DOD) for conducting various air-to-air and air-to-surface operations. Nine military warning areas and five water test areas are located within the Gulf (Figure 2-1). These warning and water test areas are multiple-use areas where military operations and oil and gas development have coexisted without conflict for many years.

The Western Gulf has four warning areas that are used for military operations. The areas total approximately 21 million ac or 58 percent of the area of the WPA.

In addition, six blocks in the Western Gulf are used by the Navy for mine warfare testing and training. Mustang Island Area Blocks 793, 799, and 816 have been excluded from proposed action. Mustang Island Area Blocks 59, 147, 228, 602, 775, 790, 191, 798, 821, and 822; and Mustang Island Area, East Addition, Blocks 732, 733, and 734 will carry multiuse mitigation stipulations, if leased.

The CPA has five designated military warning areas that are used for military operations. These areas total approximately 11.3 million ac. Portions of the Eglin Water Test Areas (EWTA) comprise an additional 0.5 million ac in the CPA. The total 11.8 million ac is about 25 percent of the area of the CPA.

4.1.3.2.5. Artificial Reefs and Rigs-to-Reefs Development

Artificial reefs have been used along the coastline of the United States since the early 19th century. Stone (1974) documented that the use of obsolete materials to create artificial reefs has provided valuable habitat for numerous species of fish in areas devoid of natural hard bottom. Stone et al. (1979) found reefs in marine waters not only attract fish, but in some instances also enhance the production of fish.

All OCS platforms have the potential to serve as artificial reefs. Offshore oil and gas platforms began providing artificial reef substrate in the Gulf of Mexico with the first platform installation in 1942. At present, there are nearly 4,000 platforms operating on the Gulf OCS. Of these platforms, 87 percent are in the CPA and 13 percent are in the WPA. The number changes as platforms are installed and removed on a regular basis. Figure 9-5 shows the distribution of oil and gas platforms across the Gulf of Mexico. These platforms comprise a large percentage of hard substrate in the Gulf. Consequently, this hard substrate has created the most extensive *de facto* artificial reef system in the world (Dauterive, 2000; Reggio, 1987; Stanley 1994).

Historically, approximately 8 percent of the platforms decommissioned in the Gulf OCS have become used in the Rigs-to-Reefs (RTR) program. The RTR development anticipated for the OCS Program for the years 2003-2042 is expected to increase and to exceed the number of RTR's that have resulted since the initial artificial reef and RTR projects in 1979 and 1982, respectively (Dauterive, 2000). This projection is based on the fact that the number of platform removals (1,258) during the 10-year period 1990-1999 almost kept pace with the number of platforms installed (1,414) during the same period (Chapter 9.1.5). Also, the number of platform removals in 1990-1999 (1,258) exceeded the total number of platforms removed during the previous 16 years (the first platform removal occurred in 1974). The increased rate of removals in the 1990's provided a greater number of platforms available for RTR. This platform removal rate is projected to continue through the years 2003-2042. The exact number and percentage of the 4,149 platforms projected to be removed that will be available for RTR will be dependent on the location and water depth of the platforms.

Proposed Action Scenario: The number of platforms projected for a proposed action in the CPA is 28-50 and in the WPA it is 11-17 (Tables 4-2 and 4-3). All platforms installed and serving as *de facto* artificial reefs under a proposed action in the CPA or WPA are projected to be removed by the end of the analysis period. The maximum number of RTR's anticipated as a result of a proposed action in the CPA is 5 and in the WPA it is 2 (approximately 10% of the maximum number of platforms decommissioned and removed). This number could vary, however, depending on where and in what water depth the platforms are installed.

OCS Program Scenario: For the OCS Program for the years 2003-2042, a total of 4,149 platforms are projected to be installed. This number includes platforms projected to be installed in the WPA, CPA, and EPA during this 40-year period from past and future lease sales as well as from the proposed actions (Tables 4-2 through 4-7). If approximately 10 percent of these decommissioned platforms were to be used for RTR's, there may be as many as 400 additional RTR's Gulfwide.

4.1.3.3. Other Major Influencing Factors on Coastal Environments

4.1.3.3.1. Submergence of Wetlands

Submergence of wetlands along the Gulf Coast is caused by eustatic sea-level rise and land subsidence. Eustatic sea-level rise is caused by the reduction of the volume of water stored in the polar ice caps. Land subsidence is caused by a variety of localized natural and manmade events such as down-warping or horizontal movement of the earth's crust; weighted surface compression; and oxidation, consolidation, settling, and dewatering of surface sediments (Swanson and Thurlow, 1973). In localized areas, subsidence and sea-level rise can be offset by sedimentation, placement of dredged material, and peat formation.

During this century, the rate of eustatic sea-level rise along the Louisiana coast has been relatively constant at 2.3 mm/yr (23 cm/century), although the rate has varied from a sea-level decrease of 3 mm/yr to a maximum increase of 10 mm/yr over decade-long periods (Turner and Cahoon, 1988). Submergence in the Gulf is occurring most rapidly along the Louisiana coast and more slowly in other coastal states. Depending on local geologic conditions, the subsidence rate varies across coastal Louisiana from 3 to 10 mm/yr. One of the major factors causing greater submergence rates in Louisiana is reduced sedimentation, resulting from deltaic abandonment, flood control, and channelization of the Mississippi River.

Fluid withdrawal can cause localized subsidence above the producing reservoirs. In coastal Louisiana, about 400 km^2 of wetlands have a subsidence potential greater than 10 cm because of fluid withdrawal (Turner and Cahoon, 1988).

4.1.3.3.2. River Development and Flood Control Projects

In recent decades, alterations in the upstream hydrology of the rivers draining into the northern Gulf of Mexico have resulted in a variety of coastal impacts. Dams and reservoirs on upstream tributaries trap much of the sediment load in the rivers. The suspended sediment load of the Mississippi River has decreased nearly 60 percent since the 1950's, largely as a result of dam and reservoir construction upstream (Tuttle and Combe, 1981; Turner and Cahoon, 1988).

In a natural system, over-bank flooding introduces sediments into adjoining wetlands. Flood control on the Mississippi and other rivers has largely eliminated flood-borne sedimentation in the Gulf coastal wetlands, contributing to their deterioration.

Channelization of the Mississippi and other rivers in conjunction with flood control levees has also contributed to wetland loss and has interrupted wetland creation around the Gulf by preventing distribution of alluvial sediments across deltas and flood plains. Prior to channelization, the flow of rivers was distributed among several distributary channels that delivered sediment over a broad area during high river stages. Today, sediment from the Mississippi River is primarily discharged through the main channel directly to the deep waters of the continental slope. The only significant exception to this scenario is the diversion of approximately 30 percent of the Mississippi River flow to the Atchafalaya River; this diversion does not capture 30 percent of the sediment flow, however, since most of the sediment is restricted to the deeper river channel.

4.1.3.3.3. Dredging

Dredging operations include sediment and gravel harvesting; pipeline installation; canal installation, maintenance, and modifications; harbor installation and maintenance; and stream channelization.

Numerous channels are maintained throughout the onshore cumulative activity area by Federal, State, county, commercial, and private interests. Proposals for new and maintenance dredging projects are reviewed by Federal, State, and county agencies as well as by private and commercial interests to identify and mitigate adverse impacts upon social, economic, and environmental resources.

Typically, the COE schedules surveys every two years on each navigation channel under its responsibility to determine the need for maintenance dredging. Maintenance dredging is then performed on an as-needed basis. Dredging cycles vary broadly from channel to channel and from channel segment to channel segment. A cycle may be 1-6 years. The COE is charged with maintaining all larger navigation channels in the cumulative activity area. The COE dredges millions of m^3 of dredged material per year in the cumulative activity area. Some shallower port-access channels may be deepened over the next 10 years to accommodate deeper draft vessels. These vessels, which support deepwater OCS activities, may include those with drafts to about 7 m.

Materials from maintenance dredging are primarily disposed of on existing dredged-material disposal banks and in dredged-material disposal areas. Additional dredged-material disposal areas for maintenance or new-project dredging are developed as needed and must be evaluated and permitted by the COE and relevant State agencies prior to construction. Some dredged sediments are dispersed into offshore waters at established offshore disposal sites.

When placing the material on a typical dredged material disposal site, the usual fluid nature of the mud and subsequent erosion causes widening of the site, which may bury adjacent wetlands, submerged vegetation, or nonvegetated water bottoms. Consequently, adjacent soil surfaces may be elevated, converting wetlands to uplands, fringes of shallow waterbodies to wetlands, and some nonvegetated water bottoms to shallower water bottoms or emergent areas that may become vegetated due to increased light at the new soil surface.

Dredged materials from channels are often contaminated with toxic heavy metals, organic chemicals, pesticides, oil and grease, and other pollutants originating from municipal, industrial, and vessel discharges and nonpoint sources, and thus can result in contamination of areas formerly isolated from major anthropogenic sources (USEPA, 1979). The vicinities around harbors and industrial sites are most noted for this problem. Hence, sediment discharges from dredging operations can be major point sources of pollution in coastal waters in and around the Gulf. In addition, inland and shallow offshore disposal can change the navigability and natural flow or circulation of waterbodies.

In 1989, USEPA estimated that more than 90 percent of the volume of material dumped in the oceans around the U.S. consisted of sediments dredged from U.S. harbors and channels (USEPA, 1989a). As of February 1997, in response to the Marine Protection, Research, and Sanctuaries Act of 1972, USEPA had finalized the designation of eight dredged-material disposal sites in the cumulative activity area. Another four sites in the Gulf are considered interim sites for dredged-material disposal. These sites primarily facilitate the COE's bar-channel dredging program. Generally, each bar channel of navigation channels connecting the Gulf and inland regions has 1-3 disposal sites used for disposal of maintenance dredged material. These are usually located in State waters. Some designated sites have never been used.

Installation and maintenance of any navigation channel and many pipeline canals connecting two or more waterbodies changes the hydrodynamics in their vicinity. These changes are typically associated with saltwater intrusion, reduced freshwater retention, changed circulation patterns, changed flow velocities, and erosion. When these channels are permitted for construction through sensitive wetland habitats or when sites are permitted for dredged-material disposal, measures are required to mitigate unavoidable adverse environmental impacts. Structures constructed to mitigate adverse hydrodynamic impacts and accelerated erosion include dams, weirs, bulkheads, rip-rap, shell/gravel mats, and gobi mats.

Typically, little or no maintenance is performed on mitigation structures. Without maintenance, many mitigation facilities, particularly in regions where the soil is poorly consolidated and has a high organic content, are known to become ineffective within a few years of construction. The number of mitigation structures associated with navigation and pipeline channels is unknown.

4.1.3.4. Major Sources of Oil Contamination in the Gulf of Mexico

Petroleum hydrocarbons can enter the Gulf of Mexico from a number of offshore, coastal, and land-based sources. Major sources of petroleum hydrocarbons into Gulf waters include (1) natural seeps; (2) accidental spills; (3) operational discharges from oil industry and maritime operations; (4) atmospheric inputs; (5) coastal, municipal, and industrial waste discharges; and (6) urban and river runoff. Information on most of these sources is summarized below. The presence of petroleum hydrocarbons in the marine environment is, to some extent, unavoidable. Hydrocarbons in Gulf waters have been identified as generated by both natural geochemical processes and from anthropogenic inputs (pyrogenic and petrogenic). The onshore anthropogenic sources of hydrocarbons to Gulf waters (the small, chronic leaks, waste discharges from the daily activities of society, and accidents) far outweigh the sources from offshore domestic production of oil.

Mass Balance of Oil Inputs into Gulf Waters

The MMS completed a mass balance of the major sources of oil inputs entering Gulf waters in 1995. It is provided here to give a perspective of the relative contribution of OCS operations compared to other sources of oil that could enter Gulf waters. It is important to understand that this exercise provides only "order-of-magnitude" estimates. There are major problems associated with any attempt to establish values for the inputs and flux of oil into the Gulf. The approach taken here is to use the concepts, assumptions, and estimates (when applicable) developed by the National Academy of Sciences (NAS) (NRC, 1985) and to apply them to Gulf of Mexico values. When possible, any sources that revised NAS estimates or assumptions were also used. The numbers have been revised to reflect the current projections of spills (discussed below). The contribution from petroleum sources from Mexico and Cuba was not calculated.

At present, the National Research Council, Ocean Science Board of the NAS, is updating the NAS estimates for oil in the sea relied on for this analysis. The MMS is working with the subcommittee in updating the contribution of all sources to the world ocean. However, results are not available at this time. The mass balance shown in Table 4-16 was calculated in 1995. The MMS has recalculated the contribution from spills based on the calculations used in Table 4-17. Although minor changes to the total volumes have occurred, these changes do not modify Table 4-16.

4.1.3.4.1. Inputs from Natural Seeps

Naturally occurring hydrocarbon seepage has long been identified as a significant source of hydrocarbons. Tarballs coming from natural seeps were used by early indigenous man living along the Gulf Coast to construct hunting tools. Given that the Gulf is a prolific petroleum-producing province, its seafloor is pocketed with areas from which oil and gas seeps. Accurately calculating the volume of oil naturally seeping is problematic. Often the volume measured floating on the surface of the water or beached has been used as the best indicator of the volume originally seeped. MacDonald et al. (1993) estimated the volume of natural seepage for an area of the continental slope off Louisiana by using satellite imagery. He estimated a natural seepage rate of about 120,000 bbl per year (0.016 Mta) from a 23,000 km^2 area. Earlier estimates by Wilson et al. (1973) were based on the geologic potential of one area relative to another. Wilson estimated that the U.S. and Mexican Gulf areas could be seeping as much as 204,000 bbl of oil per year (0.027 Mta) (Table 4-15). Given that MacDonald's estimate would be a significant subset of Wilson's estimates, the numbers appear to be within reason. This mass balance relies on Wilson's earlier estimate, despite the limitations of its calculations.

4.1.3.4.2. Inputs from Spills

The total contribution of petroleum inputs to Gulf waters from spills is estimated to be about 80,000 bbl per year or 0.01 million metric tons annually (Mta). The projected contribution from non-OCS-related spills is an order of magnitude greater than the amount projected to be spilled annually from OCS-related spills.

Oil spills can happen from a large variety of sources, including tankers, barges, other vessels, pipelines, storage tanks and facilities, production wells, trucks, railcars, and mystery sources. Spills are usually accidental but can include intentional releases of oil cargo, fuel and bunker oils, machinery space, and bilge oil.

4.1.3.4.2.1. Trends in Spill Volumes and Numbers

Databases on spills that have occurred in the Gulf of Mexico are not completed. As almost 38 percent of all U.S. spills have occurred within the waters of the Gulf of Mexico and Gulf Coast States, the trends for all U.S. spills is assumed to be representative of trends in spills that have occurred in the northern Gulf of Mexico. The following is a summary of what is known about trends in U.S. spill risk and is derived from USGS data (USDOT, Coast Guard, 2001a):

- Volumes
  - The volume of spill incidents in U.S. waters has been on a steady downward trend since 1973. There has been a general downward trend in the number of spills over 1,000 gallons (24 bbl).
  - There have been no oil spills over a million gallons since 1991.
  - The majority of spills since 1973 involved discharges between 1 and 100 gallons.
  - The decline in oil-spill volume, particularly in the face of growing domestic demand for imported oil, represents the combined effects of an increasingly effective campaign of positive prevention and preparedness initiatives to protect U.S. coastal waters from oil pollution.
  - The total volume of oil spilled per year is significantly declining. The total volume spilled in 2000 is at the lowest amount in ove r25 years.
  - The total number of spill incidents remains relatively constant from year to year.
- Location
  - 75.1 percent of all spills from 1973 to 2000 occurred within 3 nmi of shore.
  - 83.8 percent of the volume of all spills occurred in waters within 3 nmi of shore.
  - Overall, the greater majority of spills and spill volumes occur in Gulf of Mexico coastal waters and rivers draining into the Gulf; 63.7% of all spills from 1973 to 2000 occurred on rivers, canals, harbors, and in the Gulf of Mexico.
- Sources
  - Spills from tank vessels (ships/barges) account for the majority of volume spilled.
  - 32 percent of the number of all spills from 1973 to 2000 occurred from non-tank vessels; 25.2 percent were "mystery" spills; 29.1 percent were from facilities and other non-vessels; 10.2 percent were from tank vessels (ships and barges carrying oil); and 3.5 percent were from pipelines.
  - 46.8 percent of the volume of oil spilled from 1973 to 2000 came from tank vessels; 22 percent from facilities and other non-vessels; 17.5 percent from pipelines; 7.7 percent from mystery spills; and 5.9 percent from non-tank vessels.
  - The rates for oil spills ≥ 1,000 bbl from OCS platforms, tankers, and barges continues to decline.
- Types of Oil
  - A combination of crude oil and heavy oil is the type of oil with the greatest volumes spilled (62%).
  - Crude oil and heavy oil were the most frequent types of oil spilled (36% of the number of spills from 1973 to 2000 were the discharge of crude oil or heavy oil).

4.1.3.4.2.2. Projections of Future Spill Events

Table 4-16 provides the estimated number of all spill events that the MMS projects will occur within coastal and offshore waters of the Gulf of Mexico area for a representative future year (around 15 years after the proposed action). No annual average for all spills is appropriate because the timeframes and peak years vary for the different types of activities that could spill oil. State oil production in the U.S. is expected to decline over the next 15 years or so. Because the energy needs of this Nation are projected to continue to increase dramatically, any decline in domestic oil production must be replaced by imports of both crude oil and petroleum products from outside this country or replaced by alternative energy sources.

The projections of future spill occurrences shown in Table 4-16 were formulated using the following sources: an MMS analysis of the USCG database on spill incidents in all navigable waters (USDOT, Coast Guard, 2001a), an analysis completed on MMS's database, an analysis of crude oil and petroleum product spills ≥ 1,000 bbl from OCS operations, and tanker and barge operations (Anderson and LaBelle, 2000); and a 1992 analysis of spills that projected tanker and barge spills as a function of volumes of oil moved in Gulf waters by various transport modes (Rainey, 1992). Database information was supplemented by personal communications with a number of individuals dealing with vessel transport and oil-spill incidents in the Gulf of Mexico area. See Table 4-18 for the spill occurrence rates for spills used in these calculations.

4.1.3.4.2.3. OCS-Related Offshore Oil Spills

Spills could happen because of an accident associated with future OCS operations. Spills estimated to occur as a result of a proposed action (Chapter 4.4.1.) are a subset of all potential OCS spills; therefore, the discussion and information found in Chapter 4.4.1.4 on MMS estimates of future spill sizes, characteristics, and fate is incorporated here by reference.

Probability of OCS Offshore Spills ≥ 1,000 bbl Occurring: The probabilities of one or more offshore spills ≥1,000 bbl occurring from future OCS operations are provided in Table 4-19. The last column in the table provides the chance of one or more spills occurring for each planning area and for Gulfwide OCS operations. For the Gulfwide OCS Program, there is a greater than 99 percent chance that there will be an offshore spill ≥1,000 bbl occurring in the next 40 years.

Probability of OCS Offshore Spills ≥ 10,000 bbl Occurring: The probabilities of one or more offshore spills ≥10,000 bbl occurring from future OCS operations are provided in Table 4-19. The last column in the table provides the chance of one or more spills occurring for each planning area and for Gulfwide OCS operations. For the Gulfwide OCS Program, there is greater than a 99 percent chance that one or more spills ≥10,000 bbl will occur in the next 40 years.

Mean Number of OCS Offshore Spills (OCS Program): Based on a statistical analysis of spill rates and projected sources, and using the low and high resource estimates, MMS projected the mean number of offshore oil-spill events estimated to occur and the likelihood that these events will occur from OCS Program activities. Table 4-19 provides the mean number of offshore spills ≥1,000 bbl and ≥10,000 bbl estimated by source and for each planning area, as well as the Gulfwide OCS Program. The mean number of spills ≥1,000 bbl that could happen from future Gulfwide OCS Program operations during a 40-year period is estimated to be between 23 and 33 spills; the mean number of spills >10,000 bbl for the Gulfwide OCS Program is estimated to be between 6 and 9 spills.

The estimated number of possible spills ≥1,000 bbl that could occur shows a widespread frequency distribution. Figures 4-7, 4-8, and 4-9 show that there is a great deal of uncertainty as to the number of future OCS spills that will occur. If the low resource estimate is realized, the number of possible spills ≥1,000 bbl that could occur ranges from 13 to 35, with a mean number of 23 spills estimated. For the high resource estimate, the number ranges from 21 to 40, with the mean number being 33. The mean number of spills that could occur was estimated by the MMS for different size categories for the Gulfwide OCS Program. The following table provides MMS's estimate of the mean number of spills to occur in each size grouping.

Estimated Number of Offshore Spill Events (mean)
by Size Category for Different OCS Oil Development Scenarios

Size Category	OCS Program – Gulfwide
≤1 bbl	51,550-74,050
>1 and <50 bbl	1,150-1,650
≥50 and <1,000 bbl	250-350
≥1,000 bbl and <10,000 bbl	17-24
≥10,000 bbl	6-9

Sources of OCS Offshore Spills: Table 4-19 also distinguishes spill occurrence risk by likely operation or source. Besides spills occurring from facilities and during pipeline transport, as was the only case for a proposed action, offshore spills could occur due to OCS future operations from an FPSO or from shuttle tankers transporting OCS crude oil into ports. Table 4-19 includes the likelihood of a spill from a shuttle tanker accident carrying OCS produced crude oil. The scenario with the highest risk of spill occurrence is the high-case resource estimate for the OCS Program in the CPA, which assumes some shuttle-tanker transport of OCS-produced oil. Under that scenario, there is a 49 percent chance that a spill ≥1,000 bbl and a 21 percent chance that a spill ≥10,000 bbl would occur from an OCS-related shuttle tanker during the 40-year analysis period.

Estimated Spill Size: Table 4-17 shows the estimated spill sizes for OCS spills. Offshore spill sizes were calculated based on historical records and shown in Table 4-20. For spills ≥ 1,000 bbl, the median spill size was used because it better represents a likely spill size rather than the average, which is skewed by a few very large events.

Annual Numbers: Using these numbers, MMS's estimates an annual number of spills that will occur in coastal waters or Federal offshore waters due to Gulfwide OCS-related mishaps. These numbers are provided in Table 4-17 for various size groups and for a representative future year.

4.1.3.4.2.4. Non-OCS-Related Offshore Spills

Most non-OCS offshore spills occur from vessel and barge operations. Transit spills occur from navigation-related accidents such as collisions and groundings. Intrinsic spills are those occurring from accidents associated with the vessel itself, such as leaks from hull cracks, broken seals, and bilge upsets. Transfer spills occur during cargo transfer from accidents such as hose ruptures, overflows, and equipment failures.

Collisions and groundings have occurred very infrequently, less than one per 1,000 trips (USDOT, Coast Guard, 1993) and do not usually result in an oil spill. However, these accidents have resulted in the largest spills. The frequency of vessel collisions, and thus associated spills, increases as the proximity to shore increases because of the often-congested waterways in the Gulf region.

Most small non-OCS offshore spills occur during the cargo transfer of fuel and crude oil. Lightering of oil (the transfer of crude oil from supertankers to smaller shuttle tankers) is a common occurrence in the Gulf of Mexico. There have been about 3-4 spills per 1,000 lightering transfers, with an average spill size of 3 bbl (USDOT, Coast Guard, 1993).

Table 4-17 provides the MMS's projections of spills that could occur offshore from non-OCS sources for a typical future year. It is assumed that all offshore spills ≥1,000 not related to OCS operations will occur from the extensive maritime barging and tankering operations that occur in offshore waters of the Gulf of Mexico. The analysis of spills from tankers and barges ≥ 1,000 bbl is based on an analysis of numbers of spills that occur annually from different modes of transportation of oil within the Gulf region (Rainey, 1992). A total of 3-4 spills ≥1,000 bbl is projected to occur for a typical future year from the extensive tanker and barge operations. Spill sizes for the spills projected ≥1,000 bbl are derived from median spill sizes for the particular sources found in Anderson and LaBelle (2000).

The estimate for spills <1,000 bbl that occur annually offshore and are not related to OCS operations was obtained from the Marine Safety Office, Pollution Response Department of the 8^{th} USCG District (USDOT, Coast Guard, personal communication, 2001b). They estimated this number to be 200-250 spills <1,000 bbl occurring offshore annually from all non-OCS sources. The average spill size of 6 bbl was derived by an analysis of all USCG data of spills.

4.1.3.4.2.5. OCS-Related Coastal Spills

The MMS calculates the number of coastal spills that could occur as a result of future OCS operations as a subset of all coastal spills. The MMS does not regulate the operations that could spill oil in the coastal zone and does not maintain a database on these spills. MMS relies on spill data obtained from the USCG Marine Safety Information System database and from State agencies. However, these databases do not differentiate between spills associated with OCS and non-OCS activities. The MMS uses the total annual spill occurrence record for the Gulf area to estimate the number of coastal oil spills attributable to the OCS Program. All spills occurring in the Gulf of Mexico were proportioned by coastal area using the volumes of oil handled by the major oil-handling operations (Rainey, 1992). These operations include OCS support operations, State oil and gas production, intra-Gulf transport, and coastal import/export oil activities. The volume percentage related to OCS operations of the total volume of crude oil produced or transported in the Gulf area is then used to approximate the percentage of spills likely to have occurred as a result of OCS oil-handling operations. For pipeline spills, the number of known pipeline spills is proportioned by the two major sources of oil piped: State oil and gas operations, and OCS production. Based on these percentages, future spill risk is projected.

Table 4-17 provides the MMS's projections of the number of spills that will occur in the coastal waters of the Gulf of Mexico (State offshore and inland coastal waters) in a typical future year as a result of operations that support the OCS Program. About 1 spill ≥1,000 bbl and about 75-100 spills <1,000 bbl are estimated to occur each year. The one spill ≥1,000 bbl would likely be from a pipeline accident.

Some assumptions about the likely locations of these spills are made. Because the numbers are subsets of all spills, the numbers include spill events that would occur after the oil is offloaded at the primary onshore storage location, such as spills at refineries, from intra-Gulf barging of the oil, etc. Given this, it is assumed that the spill risk would be widely distributed in the coastal zone, but primarily within the Houston/Galveston area of Texas and the deltaic area of Louisiana. Based on an MMS analysis of the USCG data on all U.S. coastal spills, MMS estimates that 42 percent of OCS coastal spills will occur in State offshore waters 0-3 mi from shore, 1.5 percent will occur in State offshore waters 3-12 mi from shore, and 57 percent will occur in inland waters. It is assumed all offshore coastal spills will contact land and proximate resources.

For OCS coastal spills <1,000 bbl, a spill size of 6 bbl is assumed; for OCS coastal spills ≥1,000 bbl, a spill size of 4,200 bbl is assumed. These assumed sizes are based on analysis of the USCG spill database and on composites of the median size of a pipeline spill and a barge spill (Anderson and LaBelle, 2000), which are the two most likely sources of OCS-related spills that would occur in coastal waters and be ≥1,000 bbl.

4.1.3.4.2.6. Non-OCS-Related Coastal Spills

Using the same analysis described above, MMS also estimated the number of spills that are likely to occur in the coastal zone from non-OCS sources. These projections are included on Table 4-17.

Non-OCS-related coastal spills primarily occur from vessel accidents. Vessel accidents can spill oil from the tanks of import/export tankers while at ports or in bays and harbors; from the cargo tanks of barges and tank vessels that transport crude oil and petroleum products along channels, bayous, rivers, and especially while traversing the GIWW; and from fuel tanks of all other types of vessels, such as recreational boats or grain tankers. Other sources include spills during pipeline transport of petroleum products; crude oil; State oil and gas facilities; petrochemical refinery accidents; and from storage tanks at terminals.

The majority of spills ≥1,000 bbl occur near terminals and are associated with coastal barging operations of petroleum products (Rainey, 1992). Louisiana has experienced the majority of large spills. During 1974-1999, there have been 20 crude oil spills ≥ 1,000 bbl in the Louisiana and Texas area; none occurred in Florida, Mississippi, or Alabama. During 1974-1990, there were 19 petroleum product spills in Louisiana's coastal area (Rainey, 1992). The majority of these spills occurred on the Mississippi River, making the River the most likely location of coastal spills. Between 1993 and 1996, there have been approximately 12 spills ≥1,000 bbl from pipelines in Texas and Louisiana coastal waters.

For spills <1,000 bbl, most non-OCS coastal spills occur most frequently during transfer operations—about 5-6 spills per 1,000 transfers of oil at ports and terminals, with an average spill size of 18 bbl.

The MMS estimated the likely spill sizes for spills occurring in the coastal zone from non-OCS sources. For spills ≥1,000 bbl, the median spill size for tankers in-port and the median spill size for barges carrying petroleum products was used, based on an MMS published analysis of spill data (Anderson and LaBelle, 2000). For spills <1,000 bbl estimated to occur, MMS analyzed the USCG data on all U.S. spills less than 50,000 gallons (1,190 bbl) and determined the average size spill for this category was 6 bbl.

Based on an MMS analysis of U.S. spill data maintained by the USCG (USDOT, Coast Guard, 2001a), the historical percentages of coastal spill occurrences in different waterbody types were calculated to be as follows: 47 percent have occurred in rivers and canals; 18 percent in bays and sounds; and 35 percent in harbors. The data can also be broken down by relative location to Federal waters: 32 percent of all coastal spills occur in State offshore waters 0-3 mi from shore; 4 percent occur in State offshore waters 3-12 mi from shore; and 64 percent occur in inland waters.

4.1.3.4.3. Operational Discharges

While larger oil spills capture the public's attention and can cause short-term detrimental effects, it is the chronic, low-level inputs of petroleum hydrocarbons that represent the greatest source of petroleum released into the Gulf of Mexico. Major sources of hydrocarbon inputs include illegal operational discharges from tankers while at sea; natural seepage; and coastal, municipal, and industrial discharges and runoff. The MARPOL regulations have significantly reduced the levels of operational discharges associated with vessel operations. Terminals are now required to maintain onshore disposal facilities for receipt of this waste. The MMS expects that NAS's 1985 projection of the amount of oil entering the world ocean from operational discharges from vessels (47% of the total contribution) will be reduced significantly when they publish their updated projections. No estimate is therefore provided here. Besides oil spills from OCS operations, OCS operations are routinely discharging small amounts of oil in their wastewater discharges, primarily the discharge of produced waters. Produced water, when discharged overboard (after treatment that removes the majority of the entrained oil content), is limited by the USEPA effluent limitation guidelines to containing a monthly average of 29 mg/l oil content (USEPA, 1993a and b). The total amount of OCS produced-water discharged was projected (for amounts, see the Final EIS for Sales 157 and 161 [USDOI, MMS, 1995]) and multiplied by the monthly average to estimate the contribution to the petroleum levels in Gulf waters from OCS discharged of produced waters. This calculation results in 0.003 Mta of petroleum hydrocarbons entering Gulf waters from operational produced-water discharges associated with OCS production (Table 4-16).

4.1.3.4.4. Upriver Runoff

The Mississippi River is the major source of petroleum contamination in the Gulf of Mexico, carrying large quantities of petroleum hydrocarbons into Gulf waters from land-based drainage that eventually reaches the Mississippi River or its tributaries, as well as from coastal communities located directly along its route. Gulf of Mexico sediment samples collected within a broad crescent around the Mississippi River show petroleum contamination from the River's discharge (Bedding, 1981; Brooks and Giammona, 1988). The NAS (NRC, 1985) estimates that 0.013 Mta of hydrocarbons enter ocean water from river runoff, draining the interior of the United States. Using the fact that the Mississippi River drains two-thirds of the U.S., petroleum hydrocarbons in the River's discharge are calculated by taking two-thirds of 0.013 Mta; about 0.009 Mta. This estimate only includes runoff entering the Gulf from activities upriver from New Orleans, Louisiana. The hydrocarbon burden measured at the mouth of the Mississippi River is also from coastal inputs. Large quantities of petroleum hydrocarbons are also contributed by primarily urban runoff and by the routine, low-level effluents from industry wastewater and municipalities located along the river in the area near the Gulf of Mexico.. The contributions of these sources are calculated separately from river runoff and are accounted for in the following estimates of inputs from other chronic, low-level sources.

4.1.3.4.5. Urban Runoff and Municipal Wastewater from Coastal Communities

Man's extensive use of fossil fuels, as well as lack of recycling discarded oils, is reflected in the large contributions of petroleum hydrocarbons found in municipal wastewater and urban runoff. Significant volumes of petroleum hydrocarbons are deposited in urban areas from a variety of sources—asphaltic roads; the protective asphaltic coatings used for roofs, pipes, etc.; oil used in two-cycle engines, especially outboard boat motors; gas station runoff; and unburned hydrocarbons in car exhaust. These sources are either directly flushed by rainfall and runoff into storm drains and into coastal waters or rivers, or are weathered, broken down, and then dispersed. The Automotive Information Council estimated in 1990 that 8.3 MMbbl (approximately 1.2 Mta) of used motor oil is generated annually in the U.S. by do-it-yourselfers (Automotive Information Council, 1990). They estimated that 60 percent of this is poured on the ground, thereby adding 5.7 MMbbl of oil to the urban environment annually (0.814 Mta). Much of this discarded oil contributes to the petroleum loading found in municipal wastewater and urban runoff. The NRC (1985) determined that municipal wastewater and urban runoff contributes almost 26 percent of petroleum contamination to the world oceans. To determine an estimate of the amount of petroleum entering the Gulf from urban runoff and municipal wastewater, the NRC methodology was applied to Gulf of Mexico statistics. Multiplying the Gulf of Mexico U.S. coastal population of 14.7

million people (USDOC, NOAA, 1990) by an average input per person results in a rough estimate of 0.024 Mta from U.S. municipal wastewater and 5,000 Mta from urban runoff (Table 4-16).

4.1.3.4.6. Industrial Effluents

Other major land-based sources of petroleum hydrocarbons in Gulf waters include refineries and other industry effluents. Coastal refineries in the Gulf area have a total design capacity of 310,000 Mta. Using a discharge rate for U.S. refineries of 0.5 g/Mta capacity (NRC, 1985), the contribution of petroleum hydrocarbons from Gulf Coast refineries is 0.0000015 Mta, which is negligible when compared with other sources.

Industrial discharges enter coastal rivers (particularly the Mississippi River) that drain into the Gulf or directly into coastal waters. If one assumes that Gulf industries are evenly distributed in the coastal zone, and if the NRC's estimate of nonrefinery industrial waste input (0.2 Mta) is multiplied by one-third (the NRC's estimate of U.S. waters compared to world waters) and then multiplied by the ratio of the U.S. coastal population to the Gulf of Mexico's U.S. population, an estimate of 0.009 Mta of industrial effluent petroleum hydrocarbon contribution can be made (Table 4-16).

Summary

There are other sources of petroleum hydrocarbons not estimated in this exercise and, therefore, a complete mass balance cannot be done. Inputs from erosion of sedimentary rocks, atmospheric inputs, operational discharges from vessels (i.e., bilge and oily ballast, and fuel oil sludge), and dredged material disposal are not quantified. Although not all sources are accounted for here, comparisons between the quantitatively significant sources discussed above have been made.

4.2. ENVIRONMENTAL IMPACTS OF THE PROPOSED CENTRAL GULF SALES AND ALTERNATIVES

4.2.1. Alternative A – The Proposed Actions

The proposed actions are proposed Central Gulf Lease Sales 185, 190, 194, 198, and 201. The sales are scheduled to be held annually in March/April 2003 through 2007. Each sale will offer for lease all unleased blocks in the Central Planning Area (CPA). It is estimated that each proposed sale could result in the discovery and production of 0.276-0.654 billion barrels of oil (BBO) and 1.590-3.300 trillion cubic feet (tcf) of gas during the period 2003-2042. A description of the proposed actions is included in Chapter 2.3. Alternatives to the proposed actions and mitigating measures are also described in Chapter 2.3.

The analyses of the potential impacts are based on a scenario for a typical proposed action. These scenarios provide assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenarios and major impact-producing factors from routine activities associated with a proposed action is included in Chapters 4.1 and 4.4. The Live Bottom (Pinnacle Trend), Topographic Features, and Military Areas Stipulations are considered part of the proposed action(s) for analysis purposes.

The scenario and analysis of potential impacts of oil spills and other accidental events are discussed in Chapter 4.4. The Gulfwide OCS Program and cumulative scenarios are discussed in Chapters 4.1. The cumulative impact analysis is presented in Chapter 4.5.

4.2.1.1. Impacts on Sensitive Coastal Environments

Impacts to the general vegetation and physical aspects of coastal environments by activities resulting from a proposed action in the CPA are considered in Chapters 4.2.1.1.1, 4.2.1.1.2, and 4.2.1.1.3. Potential impacts to barrier islands seaward of the barrier-dune system are considered in the coastal barrier beaches and associated dunes analysis. Potential impacts to barrier islands landward of the barrier-dune system are considered in the wetlands analysis. Impacts to animals that use these environments, the recreational value of beaches, and archaeological resources found there are described in impact analysis sections for those specific resources.

The major, nonaccidental, impact-producing factors associated with a proposed action that could affect these environments include navigational traffic, maintenance dredging of navigational canals, and construction and expansions of navigational canals, port facilities, processing facilities, pipelines, and pipeline-support facilities. The MMS has no direct regulatory authority over potential impact-producing factors or mitigation activities that may occur or be needed in the States' coastal zones.

4.2.1.1.1. Coastal Barrier Beaches and Associated Dunes

This section considers impacts from a proposed action in the CPA to the physical shape and structure of barrier beaches and associated dunes. The major impact-producing factors associated with a proposed action that could affect barrier beaches and dunes include pipeline emplacements, navigation channel use and dredging, and use and construction of support infrastructure in these coastal areas.

Pipeline landfall sites on barrier islands could cause accelerated beach erosion and island breaching. Studies have shown that little to no impact to barrier beaches results from modern techniques used to bring pipelines to shore, such as directional boring (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988).

Navigation channels through the sandbars at the mouths of flowing channels generally capture and remove sediments from the longshore sediment drift if the cross-sectional area of the channel is too large for natural tidal and storm exchanges to keep swept clear. Periodic maintenance dredging is expected in existing OCS-related navigation channels through barrier passes and associated bars. Jetties designed to reduce channel shoaling and maintenance dredging of bar channels affect the stability of barrier landforms if those jetties or the bar channel serve as sediment sinks that intercept sediment in longshore drift. Materials from maintenance dredging of bar and pass channels are typically discharged to nearby, ocean dump sites in the Gulf (Chapter 4.1.3.2.1). This dredging usually removes sediment from the littoral sediment drift or routes it around the beach immediately downdrift of the involved channel. Placement of dredged material in shallow coastal waters forms sandbars that can impair coastal navigation.

Adverse impacts of navigation channels can be mitigated by discharging dredged materials onto barrier beaches or strategically into longshore sediment currents downdrift of maintained channels. Adverse impacts of sediment sinks created by jetties can be further mitigated by reducing the jetty length to the minimum needed and by filling the updrift side of the jetty with appropriate sediment. Sediment traps that are created by unnecessarily large bar channels may also be mitigated by reassessing the navigational needs of the port and by appropriately reducing the depth of the channel. Mitigating adverse impacts should be addressed in accordance with requirements set forth by the appropriate Federal and State permitting agencies.

No new onshore infrastructure, except for pipeline landfalls, is expected to result from OCS Program activities in the CPA. In the past, OCS-related facilities were built in the vicinity of barrier shorelines of the CPA. The use of some existing facilities in support of a proposed action and subsequent lease sales in the CPA may extend the useful lives of those facilities. During that extended life, erosion-control structures may be installed to protect a facility. Although these measures may initially protect the facility as intended, such structures may accelerate erosion elsewhere in the vicinity. They may also cause the accumulation of sediments updrift of the structures, sediments that might have alleviated erosion downdrift of the structure. These induced erosion impacts would be most damaging locally. In Louisiana where the sediment supply is critically low, these impacts may be distributed much more broadly. These impacts will last as long as the interruption of the sediment drift continues, which may continue after the structure is removed if the hydrodynamics of the area are permanently modified.

Expansions of existing facilities located on barrier beaches or in associated dunes would cause loss and disturbance of additional habitat.

Abandoned facility sites must be cleared in accordance with Federal, State, and local government and landowner requirements. Materials and structures that would impair or divert sediment drift among the dunes and on the beach must be removed.

Proposed Action Analysis

Zero to one pipeline landfalls are projected as a result of a proposed action in the CPA. Should one be constructed, it will most likely be in Louisiana, where the large majority of the infrastructure exists for receiving oil and gas from the CPA. Such a landfall may occur in the immediate vicinity of a barrier beach and associated dunes. Wherever a landfall occurs, permitting processes encourage the use of directional boring technology to greatly reduce and perhaps eliminate impacts to barrier beaches or dunes.

The use of some existing facilities in support of activities resulting from a proposed action may extend the useful life and continued presence of those facilities. During that extended life, induced erosion impacts may occur from the use of erosion-control structures. These impacts would last as long as the interruption of the sediment drift continues, which may continue after the structure is removed if the hydrodynamics of the area are permanently modified. The severity of the impact will depend upon the site and will increase with the duration of the facility-accelerated erosion. Particularly in deltaic Louisiana, recoverability from these impacts will decrease with duration. Any impacts that result from armoring these would be proportionally attributable to a proposed action.

The average contribution of a proposed action to OCS-related vessel traffic in navigation canals is expected to be small (2%). Correspondingly, very little of the impacts resulting from maintenance dredging, wake erosion, and other secondary impacts of navigation traffic would result from a proposed action.

No new navigation channels are expected to be dredged as a result of a proposed action or OCS Program activities in the CPA. The administrators at Port Fourchon have expressed a need to further deepen the Belle Pass channel to 29 ft or greater to accommodate OCS-related supply boats that have a maximum draft of 27 ft. A small portion of this need is attributable to a proposed action.

Sediments from construction and maintenance dredging of bar channels and tidal inlets can benefit barrier beaches, if placed strategically downstream of the channel and in the interrupted longshore sediment drift. Strategic placement would help mitigate adverse impacts caused by the presence of jetties and artificially deepened tidal passes. Strategic placement of sediments may also offset adverse impacts resulting from a proposed action in the CPA. A percentage of any such benefits would be attributable to a proposed action.

Summary and Conclusion

The 0-1 pipeline landfalls projected in support of a proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods. Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A proposed action may contribute to the continued use of such facilities.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. The worst of these situations is found on the sediment-starved coasts of Louisiana, where sediments are largely organic. Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

In conclusion, a proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. A proposed action may extend the life and presence of facilities in eroding areas, which can accelerate erosion there. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

4.2.1.1.2. Wetlands

At present, Louisiana has 3,800 mi^2 of marsh and more than 800 mi^2 of swamp, most of which is located along the coast. Coastal Louisiana is made up of two wetland-dominated ecosystems, the Deltaic Plain of the Mississippi River and the Chenier Plain extending from eastern Texas through Vermilion Parish, Louisiana; both are influenced by the Mississippi River. The wetlands of Louisiana are comprised of a broad range of wetland habitat including saline, brackish, intermediate, and fresh marsh wetlands, barrier islands, cheniers, mud flats, estuarine bays, and bayous. Less than 10 percent of this land is more than 3 ft above sea level, and only where five salt domes rise above the surrounding wetlands do natural elevations exceed 35 ft above mean sea level. This region contains 25 percent of the Nation's coastal wetlands and accounts for 40 percent of all salt marshes in the lower 48 states (Dunbar et al., 1992). Because more than 90 percent of the coast is less than 3 ft above sea level, an extra 1 or 2 ft of elevation loss through subsidence, lack of sediment supply, or erosion will have drastic effects on the available wetland habitat. Current estimates predict that nearly 640,000 acres of existing wetlands (an area nearly the size of Rhode Island) will be under water in less than 50 years (Louisiana Coastal Wetlands Conservation and Restoration Task, 1993).

The OCS oil and gas activities that could potentially impact these wetland types and their associated habitats include pipeline emplacement (construction and maintenance), new and maintenance dredging of navigation channels and canals, vessel usage of navigation channels, and construction and maintenance of inshore facilities. Other potential impacts that are indirectly associated with OCS oil and gas activities are wake erosion resulting from navigational traffic, levee construction that prevents necessary sedimentary processes, saltwater intrusion that changes the hydrology leading to unfavorable conditions for wetland vegetation, and vulnerability to storm damage from eroded wetlands.

Pipelines

Most disturbances associated with pipeline construction (Chapter 4.1.2.1.7) are expected to result in temporary adverse impacts that are expected to be partially corrected after approximately 6 years (Tabberer et al., 1985; Wicker et al., 1989). Pipelines can be emplaced using a variety of techniques, which, with incorporation of mitigation measures, can influence the extent of impact to the environment. The two major emplacement techniques used historically in wetland environments are the push-pull ditch and the flotation canal methods. Currently, trenchless, or directional drilling, is a more often required technique in sensitive habitats. Impacts from this technique are limited to the access and staging sites for the equipment. This method has been used successfully to place pipelines under scenic rivers so as not to disturb the bottom water or impact the banks of the river, as well as to traverse busy navigation canals without interrupting traffic. For example, the proposed 30-in Endymion Oil Pipeline would deliver crude oil from South Pass Block 89 to the LOOP storage facility near the Clovelly Oil and Gas Field. Based on a review of the data in the COE permit application (No. 20-020-1632), the emplacement of the pipeline would cause zero (0) impacts to marshes (emergent wetlands) and beaches because the operator would use horizontal, directional (trenchless) drilling techniques to avoid damages to these sensitive habitats. Additionally, the proposed route maximizes an open-water route to the extent possible (a comprehensive description of current mitigative measures is discussed in Chapter 4.5.1.2).

A proposed action in the CPA is expected to contribute approximately 2 percent of overall impacts to wetlands and associated coastal habitats from OCS-related coastal pipeline installation and the required maintenance of those installations. As previously discussed in Chapter 4.1.1.3.8.1, petroleum reservoirs in deepwater areas might require their own pipeline landfall. The projected numbers of coastal pipeline installations and the projected lengths of coastal pipelines related to a proposed action are presented in Table 4-13.

As of August 2001, there were more than 45,000 km of pipelines in Federal offshore lands and a few thousand kilometers of OCS pipelines extend into state waters and onshore. Many OCS pipelines make landfall on Louisiana's barrier island and wetland shorelines (Falgout, 1997). Louisiana wetlands protect pipelines from waves and ensure that the lines stay buried and in place.

A major concern associated with pipeline construction is disturbance caused by backfilling. Pipeline canals are backfilled with the materials originally dredged while digging the canal. The major factors determining the success of backfilling as a means of restoration are the depth of the canal, soil type, canal dimensions, locale, dredge operator skill, and permitting conditions (Turner et al., 1994). Plugging the canal has no apparent effect on water depth or vegetation cover, with one exception—submerged aquatic vegetation was more frequently observed behind backfilled canals with plugs than in backfilled canals without plugs. Canal length and percentage of backfill returned has the greatest effect on the recovery of vegetation (Turner et al., 1994). While investigating backfilling canals as a wetland restoration technique in coastal Louisiana, Turner et al. (1994) discovered that canals that have been backfilled as mitigation for dredging done at another location are typically more shallow if they are older or in soils lower in organic content. Vegetation recovery increases with increasing canal length and percentage of material returned.

In areas where soils have high organic content, as in the Deltaic Plain or the Chenier Plain, backfilling does not usually fill a canal completely. The extent of impact from the push-pull ditch technique may be influenced by whether the ditch is backfilled and/or dammed. Dredge deposits associated with push-pull ditches are considerably less than those with flotation canals, but both have potential for impacts related to the configuration of the deposits of dredged material. For both flotation and push-pull canals, a double-ditching technique can be used to ensure that the top soil is placed on top when the site is backfilled. This expedites revegetation and lessens the potential for detrimental impacts such as land loss due to erosion along the unvegetated right-of-way.

The real loss of wetlands is difficult to determine because it depends on the pipeline emplacement technique used, amount of backfilling, time of year, and duration of construction. After pipelines are constructed and backfilled in Texas or Mississippi, a shallow channel is expected to remain where the canal passes through wetlands. In coastal Subareas LA-1, LA-2, and LA-3, some open-water areas may remain. Approximately six years after backfilling, productivity of vegetation in areas directly over the pipeline is predicted to be reduced. Less than two-thirds of new OCS pipelines do not come ashore directly but rather link up to previously existing pipelines that already make landfall; hence, no landfall or onshore pipeline construction will result (Chapter 4.1.2.1.7).

Secondary or indirect impacts of pipeline channels can be even more damaging to coastal wetlands and associated habitats than the primary impacts (Tabberer et al., 1985). Secondary impacts include expansion of tidal influence, saltwater intrusion, hydrodynamic alteration, erosion, sediment export, flank subsidence, and habitat conversion. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of these secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements. The number of OCS-related mitigative structures around the Gulf Coast is unknown.

Frequently, the lack of maintenance of structures used to mitigate adverse impacts of pipeline construction allows the structures to deteriorate and eventually fail. Consequently, the indirect, adverse impacts upon wetlands that the structures were designed to prevent or mitigate could resume and possibly proceed at an accelerated rate. No known effort has been made to document the frequency or extent of these failures or the severity of the resulting impacts. Quantifying indirect impacts to wetlands is difficult and highly debatable. The widening of pipeline canals over time is one of the more obvious secondary impacts; however, extricating secondary impacts of canals from all other losses remains a challenge. A number of studies have examined the correlative evidence linking wetland loss to canal densities (Turner et al., 1982; Saife et al., 1983; Turner and Cahoon, 1988; Turner, 1987; Bass and Turner, 1997). In general, it appears that for most of the Louisiana coast a positive relationship exists between canal density and wetland loss. The limitation of this suggestion is that it fails to identify any cause and effect relationship; however, it may provide a basis upon which to support a hypothesis about the secondary impacts of canals on wetland loss rates.

The widening of pipeline canals over time is one of the more obvious secondary impacts. Craig et al. (1980) studied a series of canals in Louisiana and determined that the canals widened at rates of 2-14 percent per year. Dead-end canals with little vessel traffic or significant flow were shown to widen at rates within this range. Based on the 1980 study and due to their shallow nature, OCS-related pipeline canals are expected to widen at an average rate of about 4 percent per year.

Up to 10 km of onshore pipeline are projected to be constructed in support of a proposed action in the CPA. Based on preliminary historic landloss results from the MMS/USGS NWRC current coastal pipeline impacts study for the Louisiana study area, the predicted landloss (based on an average of 4 ha of conversion to open water per linear km of pipeline) from the estimated 0-10 km of new OCS pipeline construction from a proposed action in the CPA would be 0-40 ha. However, this estimate does not take into consideration the following variables:

- season of construction (growing vs. non-growing);
- precipitation and/or climatic conditions;
- mitigations applied by permitting agency;
- methods of construction/installation;
- size of pipeline; and

- location of construction and associated habitats impacted.

Also, the using of new technologies of pipeline construction, such as horizontal or trenchless directional drilling, would decrease impacts to sensitive habitat to as much as zero (0).

At present, there is no known study addressing the effectiveness or longevity of canal-related mitigation. The above-mentioned study is currently identifying and mapping onshore OCS-related pipelines in the coastal regions around the Gulf, including the Chenier Plain, to ascertain direct and secondary impacts to the extent possible.

Dredging

No new navigational channels are expected to be dredged/constructed as a result of a proposed action in the CPA. Deepwater activities are anticipated to increase, requiring use of larger service vessels for efficient operations. This may put a substantial emphasis on shore bases associated with deeper channels. Some of the ports that have navigation channels deep enough to accommodate deeper-draft vessels may expand the port infrastructure to accommodate these deeper-draft vessels. An example of a significant expansion of a service base is Port Fourchon in coastal Louisiana. Port Fourchon has deepened the existing channel and has dredged additional new channels to facilitate this expansion. The administrators at Port Fourchon have expressed a need to further deepen the Belle Pass Channel to 29 ft or greater to accommodate OCS-related supply boats that have a maximum draft of 27 ft; however, project plans have not been developed.

Dredging and dredged-material disposal can be detrimental to coastal wetlands and associated fish and wildlife that use these areas for nursery grounds, protection, etc. Periodic maintenance dredging of navigation channels deposits material on existing dredged-material disposal banks and disposal areas; the effects of dredged-material disposal banks on wetland drainage is expected to continue unchanged, although there may be some localized and minor exacerbation of existing problems. Typically, some dredged material intended for placement on a dredged-material disposal bank is placed in adjacent wetlands or shallow water. Wetland loss due to dredge material deposition is expected to be offset by wetland creation as adjacent margins of shallow water are filled. In both cases, areas impacted are considered small. Maintenance dredging will also temporarily increase turbidity levels in the vicinities of the dredging and disposal of materials, which can impact emergent wetlands, seagrass communities, and associated habitats.

Two different methods are generally used to dredge and transport sediments from channels to open-water sites: (1) hydraulic cutterhead suction dredge transfers sediments via connecting pipelines; and (2) clamshell bucket dredge transfers sediments via towed bottom-release scows. Each method produces a distinctly different deposit. Hydraulic dredging creates a slurry of sediment and water, which is pumped through a pipeline to the dredged-material disposal site. Coarser sediment settles to the bottom where it spreads outward under the force of gravity; finer sediments may remain in suspension longer. The clamshell dredge scoops sediments relatively intact into scows, which are then towed to the designated area. The dredged sediments are released into the area specified for disposal. This method usually produces positive relief features in the placement area.

Access canals, as well as pipeline canals, are commonly bordered by levees created using dredged materials (Rozas, 1992). Placement of this material alongside canals converts marsh to upland, an environment unavailable to aquatic organisms except during extreme tides. Dredge material can also form a barrier causing ponding behind levees and limiting circulation between canal waters and marshes to infrequent, high-water events (Swenson and Turner 1987; Cox et al., 1997). This and similar disruptions to marsh hydrology are believed to change coastal habitat structure as well as accelerate marsh erosion and conversion to open water (Kuhn et al., 1999; Turner et al., 1994; Rozas, 1992; Turner and Cahoon, 1987). The MMS/USGS-BRD study previously mentioned above (pipelines) will attempt to quantify the impacts of dredge material deposition as well as other canal-related impacts, which should provide insights for identifying past and future impacts.

Executive Order 11990 requires that material from maintenance dredging be considered for use as a sediment supplement in deteriorating wetland areas to enhance and increase wetland acreage, where appropriate. Disposal of dredged material for marsh enhancement has been done only on a limited basis (Chapter 4.1.2.1). Given the "mission statement" of the COE, which requires it to take environmental impacts into consideration during its decisionmaking processes, increased emphasis has been placed on the use of dredged material for marsh creation. For a proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

Vessel Traffic

Vessel traffic that may support a proposed action is discussed in Chapter 4.1.1.3.8.4. Navigation channels projected to be used in support of a CPA proposed action are discussed in Chapter 4.1.2.1.9. Navigation channels that support the OCS Program are listed in Table 3-30. Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by natural erosion process. An increase in the number of vessels creating wakes could potentially impact coastal habitat including wetlands.

According to Johnson and Gosselink (1982), canals that have high navigation usage in coastal Louisiana widen about 2.58 m/yr, compared with 0.95 m/yr for little used canals. The OCS-related navigation canals are assumed to generally widen at an average rate of 1.5 m/yr. Approximately 3,200 km of OCS-related navigation canals, bayous, and rivers are found in the coastal regions around the Gulf, exclusive of channels through large bays, sounds, and lagoons. About 700 km of these channels are found around the WPA; another 2,000 km is found in the CPA.

Specific to navigation channels are the effects from saltwater intrusion (Gosselink et al., 1979; Wang 1987). Wang (1987) developed a model demonstrating that, under certain environmental conditions, salt water penetrates farther inland in deep navigation channels than in shallower channels, suggesting that navigation channels act as “salt pumps.” The Calcasieu Ship Channel is a good example of how saltwater intrusion, as a consequence of channelization, results in significant habitat transition from freshwater to brackish and ultimately to salt or open-water systems. Another example is the construction of the Mississippi River Gulf Outlet that led to the transition of many of the cypress swamps east of the Mississippi River below New Orleans to open water or areas largely composed of marsh vegetation (*Spartina)* with old, dead cypress tree trunks.

There are two major waterways that support vessel traffic associated with OCS activities: (1) the Gulf Intracoastal Waterway (GIWW) completed in 1949, and (2) the Mississippi River Gulf Outlet (MRGO) opened through the wetlands of St. Bernard Parish in 1963. The GIWW carries barges of crude oil, petroleum, bulk cargoes, and miscellaneous items along a 12-ft deep channel protected from the storms, waves, and winds of the Gulf of Mexico. Maintenance dredging of the MRGO has always been necessary, especially in areas such as Breton Sound where the channel crosses open water. Through continued use of this navigation channel, annual dredging, and the instability of the banks, the main channel of the MRGO has widened from 500 to 2,000 ft in some places.

Much of the service-vessel traffic that is a necessary component of OCS activities uses the channels and canals along the Louisiana coast. An increase in the number of vessels creating wakes could potentially increase impacts to coastal habitats including wetlands.

Disposal of OCS-Related Wastes

Produced sands, oil-based or synthetic-based drilling muds and cuttings, and some fluids from well treatment, workover, and completion activities will be transported to shore for disposal. Sufficient disposal capacity exists at the disposal site near Lacassine, Louisiana (coastal Subarea LA-1) and at other disposal sites under development or projected for future development in Subareas LA-1, LA-2, and MA-1 (Chapter 4.1.2.1.10). Discharging OCS-related produced water into inshore waters has been discontinued. All OCS-produced waters are discharged into offshore waters in accordance with NPDES permits or transported to shore for injection. Produced waters are not expected to affect coastal wetlands (Chapter 4.1.1.3.4.2).

Because of wetland protection regulations, no new waste disposal site will be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation. State requirements are expected to be enforced to prevent and correct such occurrences.

Onshore Facilities

Various kinds of onshore facilities service OCS development. These facilities are described in Chapter 4.1.2.1 and Table 4-8. State and Federal permitting agencies discourage the placement of new facilities and the expansion of existing facilities in wetlands. Any impacts upon wetlands are usually mitigated. All projected new facilities are attributed to the OCS Program, with an appropriate proportion attributed to a proposed action.

Proposed Action Analysis

The 1990 estimates of coastal Louisiana wetland acreage in a nine-basin area based on the U.S. Army Corps of Engineers database is described below:

Basin	Acres of Marsh in 1990	Acres of Marsh Lost by 2050 without Restoration	Acres of Marsh Preserved by the Breaux Act and Diversions	Net Acres of Marsh Lost by 2050 at Current Restoration Levels	Acres of Swamp in 1990	Acres of Swamp Lost by 2050 at Current Restoration Levels
Pontchartrain	253,000	50,330	4,720	45,610	213,570	105,100
Breton Sound	171,100	44,480	17,900	26,580	0	0
Mississippi Delta	64,100	24,730	18,340	6,390	0	0
Barataria	423,500	134,990	42,420	92,570	146,360	80,000
Terrebonne	488,800	145,250	5,170	140,080	152,400	46,700
Atchafalaya	48,800	(30,030)*	8,080	(38,110)*	12,600	0
Teche/ Vermilion	234,300	32,160	3,360	28,800	18,390	0
Mermentau	441,000	61,710	2,600	59,110	370	0
Calcasieu/ Sabine	317,100	50,840	12,440	38,400	170	0

Source: Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1993.

Direct causes of wetland loss along the Louisiana coast potentially associated with a proposed action areas as follows:

- dredging and stream channelization for navigation channels and pipeline canals;
- filling by dredged material and other solid-waste disposal;
- roads and highways;
- industrial development and infrastructure improvement; and
- accidental discharge of pollutants into wetlands.

Indirect causes of wetland loss may be attributed to

- subsidence due to lack of natural sediment replenishment of the deltaic/wetland system caused by channel and river controls;
- sediment diversion by dams, deep channels, and other structures;
- hydrologic alterations by canals, dredged-material disposal banks, roads, and other structures; and
- subsidence due to extraction of groundwater, oil, gas, sulfur, and other minerals.

With regard to oil specifically, a proposed action is projected to represent about 2 percent of oil production and transport by the OCS Program in the Gulf during the period of 2003-2042 (derived from Table 4-1). Oil production from a proposed action is expected to be commingled in pipelines with other

OCS production before going ashore. Table 4-13 shows the distribution of projected new, OCS-related pipeline landfalls and inland pipeline lengths for a proposed action.

On average, 10 percent of traffic using OCS-related navigation channels is related to the OCS Program, and a proposed action is expected to contribute 2 percent to this usage; therefore, impact related to a proposed action should remain minimal. Since the number of OCS-related mitigative structures is unknown, impacts creditable to a proposed action cannot be calculated. Impacts associated with canals and mitigation structures include altered hydrology and flank subsidence, for which methods of projecting rates of occurrence and extent of influence have not yet been developed. An MMS study of canal-impact issues began during the summer of 1997; a final report is expected in the spring of 2002.

Summary and Conclusion

Loss of 0-40 ha of habitat is estimated as a result of 0-10 km of new pipelines projected as a result of a proposed action. Secondary impacts, such as continued widening of existing pipeline and navigation channels and canals, and failure of mitigation structures, are also expected to affect the rate at which wetlands convert to open water.

Maintenance dredging of navigation channels and canals is expected to occur with minimal impacts; a proposed action is expected to contribute minimally to the need for this dredging. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands. By artificially keeping navigation channels open and with larger dimensions than would the region's natural hydrodynamic processes, maintenance dredging maintains tidal and storm flushing potential of inland regions at maximum capacities as they relate to the described needs of the canal project. Without maintenance dredging, these channels would naturally fill in, reducing the channels' cross-sectional areas and their capacities to flush or drain a region when under the influences of storms and tides.

In conclusion, adverse initial impacts and more importantly secondary impacts of installation, maintenance, continued existence, and the failure of mitigation structures for pipeline and navigation canals are considered the most significant OCS-related and proposed-action-related impacts to wetlands. Although initial impacts are considered locally significant and largely limited to where OCS-related canals and channels pass through wetlands, secondary impacts may have substantial, progressive, and cumulative adverse impacts to the hydrologic basin or subbasin in which they are found. Impacts related to a proposed action represent a low percentage of OCS Program impacts. The broad and diffuse distribution of OCS-related activities offshore and along the Central Gulf Coast makes it difficult to distinguish proposed action impacts from other ongoing OCS and non-OCS impacts to wetlands. The MMS has initiated studies to better evaluate these impacts and related mitigative efforts.

4.2.1.1.3. Seagrass Communities

Seagrasses in the CPA are restricted to small shallow areas behind barrier islands in Mississippi and Chandeleur Sounds and to smaller, more scattered populations elsewhere. Lower-salinity, submerged seagrass beds are found inland and discontinuously throughout the coastal zone. Most beds of submerged aquatic vegetation located between the Southwest Pass of the Mississippi River and Cape San Blas, Florida, are inland of the barrier shorelines. Most submerged vegetation in this region usually remains submerged because of the micro-tidal regime of the northern Gulf. Only during extremely low, wind-driven tidal events would seagrass beds be exposed to the air. Even then, their roots and rhizomes remain buried in sediment. Activities that may result from a proposed action that could adversely affect submerged vegetation beds include pipeline construction, maintenance dredging of navigational channels, vessel traffic, oil spills, and spill response and cleanup. The potential impacts of oil spills and spill-response and cleanup activities are discussed in Chapter 4.4.3.1.3.

Pipelines

The installation of 0-1 pipeline landfalls is projected as a result of a CPA proposed action (Chapter 4.1.2.1.7). Pipeline construction methods and disturbances are discussed in Chapters 4.1.1.3.8.1 and 4.1.2.1.7. Jetting for pipeline installation displaces sediments. The denser sediments fall out of suspension quickly; the finer sediments that decrease water clarity remain in suspension longer. Reduced water clarity can decrease plant density in the seagrass beds, which in turn can further increase turbidity as the root, thatch, and leaf coverage decreases (Wolfe et al., 1988). The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow extent and productivity. As in maintenance dredging activities discussed below, activities from pipeline emplacement could reduce light, which is linked to reductions of both seagrass cover and productivity (Orth and Moore, 1983; Kenworthy and Haunert, 1991; Dunton, 1994; Czerny and Dunton, 1995).

The COE and State agencies take possible impacts to submerged vegetation into consideration during their review of pipeline permits. The permits for constructing pipelines require that turbidity impacts be mitigated through the use of turbidity screens and other turbidity reduction or confinement equipment. The permits also require surveying to locate beds of submerged vegetation, monitoring of turbidity and reporting to the COE and State agencies, and taking immediate action to correct turbidity problems.

Although the majority of materials resuspended by jetting return to the water bottom within a few meters of the trench, lighter materials can be carried for several kilometers, depending upon the currents, weather, and the density of the dredged materials. Hence, pipeline installation has the potential to bury nearby submerged vegetation; coat the leaves of plants farther away with lighter, light-blocking sediments; and temporarily elevate turbidity in these beds.

Maintenance Dredging

No new navigational channels are expected to be dredged as a result of a proposed action or OCS Program activities in the CPA. Maintenance dredging schedules vary from yearly to rarely, and will continue indefinitely into the future. Deepwater activities are anticipated to increase, which will likely require greater use of larger service vessels for efficient operations and may cause greater use of shore bases associated with deeper channels.

Some of the ports that have navigation channels deep enough to accommodate deeper-draft vessels may expand the port infrastructure to accommodate these deeper-draft vessels. An example of a significant expansion of a service base is Port Fourchon in coastal Louisiana. Port Fourchon has deepened the existing channel and has dredged additional new channels to facilitate this expansion. The administrators at Port Fourchon have expressed a need to further deepen the Belle Pass Channel to 29 ft or greater to accommodate OCS-related supply boats that have a maximum draft of 27 ft; however, project plans have not been developed.

Some of the ports that house OCS-related service bases and that can presently accommodate deeper-draft vessels have expanded their accommodations. (Service bases are discussed in Chapter 4.1.2.1.1.) In coastal Louisiana, Port Fourchon has deepened the existing channels and have dredged additional channels to facilitate this expansion. The administrators at Port Fourchon have expressed a need to further deepen the Belle Pass channel to 29 ft or greater to accommodate OCS-related supply boats that have a maximum draft of 27 ft; however, project plans have not been developed. A small portion of this need would be attributable to a proposed action.

Light attenuation is responsible for most landscape-level losses. The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow extent and productivity. Reduced light has been linked to reductions of both seagrass cover and productivity (Orth and Moore 1983; Kenworthy and Haunert 1991; Dunton 1994; Czerny and Dunton 1995). Dredging has been determined to be one of the major causes of light reduction that results in changes in seagrass cover, composition, and biomass. Changes in species composition are usually the result of natural processes (i.e., succession), but they can be caused by moderation of salinity resulting from dredging. Changes in species composition resulting from dredging activities may affect resource availability for some fish and waterfowl that use seagrass habitat as nursery grounds. Turbidity caused by maintenance dredging has been implicated in the decline of shoalgrass and increased bare areas in the lower Laguna Madre (Onuf, 1994) located behind the south Texas barrier islands.

Maintenance dredging keeps navigation channels open and artificially maintains larger channel dimensions than would occur naturally under regional hydrodynamics. Dredging also increases the potential for tidal and storm flushing of inland regions. Without maintenance dredging, these channels would naturally fill, reducing the channels' cross-sectional areas and their capacities to flush or drain a region when under the influences of exceptionally high storms and tides.

Vessel Traffic

Navigation traffic that may support a proposed action is discussed in Chapter 4.1.2.1.9. Most navigation channels projected to be used for the CPA proposed actions are shallow and currently used by vessels that support the OCS Program (Table 3-33). For example, the GIWW is dredged to 4 m, but it is actually about 5.5 m deep between the Pascagoula Channel and the Bayou LaBatre Channel and generally about 3.7 m deep between the Bayou LaBatre and Mobile Bay Channels. Prop wash of shallow navigation channels by vessel traffic dredges up and resuspends sediments, increasing the turbidity of nearby coastal waters.

Proposed Action Analysis

Pipelines

All of the gas production and most of the oil production from a CPA proposed action is expected to be mingled in pipelines with other OCS production at sea before going ashore. Seagrasses are not abundant in the Federal OCS waters where most of the length of any pipeline supporting a proposed action would be installed. For a proposed action in the CPA, any pipelines that made landfall would most likely go ashore in Mobile County, Alabama; Jackson County, Mississippi; or Plaquemines Parish, Louisiana. Many sparse and scattered beds of seagrasses and other submerged vegetation are found around the islands of these counties and parishes. Scattered and sparse beds of seagrasses are also associated with the Chandeleur and Breton Islands, through which a pipeline might pass on its way to make a landfall in Plaquemines Parish, Louisiana, or to link up with an existing pipeline. Although the majority of materials dredged by jetting return to the water bottom within a few meters of the trench, lighter materials can be carried for several kilometers, depending upon the currents, weather, and density of the dredged materials. Hence, pipeline installation has the potential to bury nearby submerged vegetation; coat the leaves of plants farther away with lighter, light-blocking sediments; and temporarily elevate turbidity in these beds. Permit requirements of the COE and State agencies are expected to require the reduction of turbidity impacts to within tolerable limits for submerged aquatic vegetation, if implemented (Chapter 4.1.2.1.7). Hence, significant direct impacts to submerged vegetation by pipeline installation are expected to be very small and short term if they occur.

Maintenance Dredging

Because much of the dredged material resulting from maintenance dredging will be placed on existing dredged-material disposal sites or used for other mitigative projects, no significant adverse impacts are expected to occur to seagrass communities from maintenance dredging related to a proposed action.

Vessel Traffic

Most of the navigation channels to be used in support of proposed action activities are shallow, therefore allowing for possible impacts to associated seagrass and submerged vegetation from propeller scarring and resuspension of sediments from propwash. Navigational traffic through the GIWW between the Bayou LaBatre Channel and Mobile Bay Channel would resuspend sediments. A proposed action would contribute to a percentage of traffic through that stretch. However, beds of submerged vegetation within the area of influence of that channel and other channels have already adjusted their configurations in response to turbidity generated there.

Vessels that vary their inland route from established navigation channels can directly scar beds of submerged vegetation with their props, keels (or flat bottoms), and anchors. Many vessel captains will cut corners of channel intersections or navigate across open water where they may unexpectedly encounter shallow water where beds of submerged aquatic vegetation may occur. Propellers may damage a bed superficially by leaving a few narrow cuts. Damage may be as extensive as broadly plowed scars from the keel of a large boat accompanied by extensive prop washing; trampling by waders; and additional keel, prop, and propwash scars left by other vessels that assisted in freeing the first boat.

Depending upon the submerged plant species involved, scars about 0.25 m wide cut through the middle of beds would take 1-7 years to recover. Similar scars through sparser areas would take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area may never be corrected (Sargent et al., 1995; Durako et al., 1992).

Denser dredged materials fall out of suspension more quickly. Less dense sediments settle to the water bottom more slowly, which concentrates at the surface of the water bottom. These lighter bottom sediments are generally more easily resuspend by storms than were the original surface sediments. Hence, for a period of time after dredging occurs, water turbidity will be greater than usual in the vicinity of the dredging. With time, this reoccurring, increased turbidity will decrease to pre-project conditions, as the lighter materials are either dispersed to deeper water by currents, where they are less available for resuspension, or they are consolidated into or under denser sediments.

For estuarine species that thrive in salinities of about 0.5-25 ppt, this elevated turbidity may not pose a significant problem, since they have adapted to turbid, estuarine conditions. For seagrasses in higher salinities and even freshwater submerged aquatic vegetation that require clearer waters, significantly reduced water clarity or shading, as may be caused by an oil slick, for longer than about 4 days will decrease chlorophyll production. If such conditions continue for longer than about 2 weeks, plant density in the bed will begin to decrease. If plant density reduces significantly in turn, further increases in turbidity will occur as the root, thatch, and leaf coverage decline. Such impacts can be mitigated in several ways. For cleaning up slicks resting over a submerged vegetation bed, wheeled or treaded vehicles should be prohibited. Cleanup methods using other vehicles that dig into the water bottom of the bed (e.g., boat anchors, boat bottoms, props, and booms that require water depths greater than that available over the bed) should be not be used. Vehicles and equipment that require minimum water depths of about 6-10 in should be used instead. Activities over grass beds should be closely monitored to avoid digging into the bed. Trampling or repeatedly walking over a path through the bed should be avoided.

Summary and Conclusion

Most seagrass communities located between the Southwest Pass of the Mississippi River and Cape San Blas, Florida, are inland of the barrier shorelines. Because of the location of most seagrass communities, inshore oil spills pose the greatest threat (discussed in Chapters 4.4.1.1.2 and 4.4.3.1.3).

Pipeline construction in coastal waters would temporarily elevate turbidity in nearby submerged vegetation beds, depending upon currents. If constructed, the pipeline landfall would temporarily elevate turbidity in submerged vegetation beds near the pipeline routes. The COE and State permit requirements are expected to require pipeline routes that avoid beds of high-salinity, submerged vegetation and to reduce turbidity impacts to within tolerable limits. Hence, impacts to submerged vegetation by pipeline installation are projected to be very small and short term.

After bottom sediments are disturbed by pipeline installation, they will be generally more easily suspended by storms than before the disturbance. In estuaries, this increase is not projected to be a problem. Due to tidal flushing, this increased turbidity is projected to be below significant levels and to continue after storms for up to one month.

Beds of submerged vegetation within a channel’s area of influence will have already adjusted to bed configurations in response to turbidity generated there. Very little, if any, damage would then occur as a result of typical channel traffic. Generally, propwash will not resuspend sediments in navigation channels beyond pre-project conditions.

Depending upon the submerged plant species involved, narrow scars in dense portions of the beds will take 1-7 years to recover. Scars through sparser areas will take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area may never be corrected.

Maintenance dredging will not have a substantial impact on existing seagrass habitat given that no new channels are expected to be dredged as a result of a CPA proposed action.

4.2.1.2. Impacts on Sensitive Offshore Resource

4.2.1.2.1. Pinnacle Trend

Seventy blocks are within the region defined as the pinnacle trend, which contains live bottoms that may be sensitive to oil and gas activities. These blocks are located in the northeastern portion of the CPA and adjacent areas of the EPA, and are located between 53 and 110 m water depths in the Main Pass and Viosca Knoll lease areas. Leases in past sales have contained a live-bottom stipulation to protect such areas. The proposed Live Bottom (Pinnacle Trend) Stipulation is presented in Chapter 2.3.1.3.2 as a potential mitigating measure for leases resulting from a proposed action. The stipulation is designed to prevent drilling activities and anchor emplacement (the major potential impacting factors on these live bottoms resulting from offshore oil and gas activities) from damaging the pinnacles. Under the stipulation, both EP and DOCD plans will be reviewed on a case-by-case basis to determine whether a proposed operation could impact a pinnacle feature. If it is determined from site-specific information derived from MMS studies, published information from other research programs, geohazards survey information, or another source that the operation would impact a pinnacle feature, the operator will be required to relocate the proposed operation. Although the Live Bottom Stipulation is regarded as a highly effective protection measure, infrequent accidental impacts are possible. Accidental impacts may be caused by operator positioning errors or when studies and/or geohazards information are inaccurate or fail to note the presence of pinnacle features. One such incident has been documented and is discussed in further detail below. While investigating sites of previous oil and gas drilling activities, Shinn et al. (1993) documented that a lease operator had located an exploratory well adjacent to a medium-relief pinnacle feature; the reason for this occurrence is still undetermined. In spite of this documented instance, the stipulation is still considered effective since it allows MMS flexibility to request any surveys or monitoring information necessary to ensure protection of these sensitive areas. The impact analysis presented below is for a typical proposed action in the CPA and includes the proposed Live Bottom (Pinnacle Trend) Stipulation.

A number of OCS-related factors may cause adverse impacts on the pinnacle trend communities and features. Damage caused by, anchoring, infrastructure and pipeline emplacement, infrastructure removal, blowouts, drilling discharges, produced-water discharges, the disposal of domestic and sanitary wastes, and oil spills can cause the immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible. Impacts from oil spills and blowouts are discussed in Chapter 4.4.

Anchoring may damage lush biological communities or the structure of the pinnacles themselves, which attract fish and other mobile marine organisms. Anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels greatly disturb areas of the seafloor and are the greatest threats to live-bottom areas at these depths. The size of the affected area would depend on water depth, anchor and chain sizes, chain length, method of placement, wind, and current. Anchor damage includes, but is not limited to, crushing and breaking of the pinnacles and associated communities. Anchoring often destroys a wide swath of habitat by being dragged over the seafloor, or the vessel swings at anchor, causing the anchor chain to drag the seafloor.

The emplacement of infrastructure, including drilling rigs and platforms, on the seafloor will crush the organisms directly beneath the legs or mat used to support the structure. The areas affected by the placement of the platforms and rigs are predominantly soft-bottom regions where the infaunal and epifaunal communities are not unique. Pipeline emplacement directly affects the benthic communities through burial and disruption of the benthos and through resuspension of sediments. These resuspended sediments may obstruct filter-feeding mechanisms and gills of fishes and sedentary invertebrates.

Both explosive and nonexplosive structure removal operations will disturb the seafloor and potentially affect nearby pinnacle communities. Structure removal using explosives (the most common removal method in these water depths) will suspend sediments throughout the water column impacting the nearby habitats. Deposition of these sediments will occur much in the same manner as discussed for muds and cuttings discharges (Chapter 4.1.1.3.4.1). Explosive structure removals create shock waves, which also harm resident biota in the immediate vicinity. O'Keeffe and Young (1984) have described the impacts of underwater explosions on various forms of sea life. They found that sessile organisms of the benthos (such as barnacles and oysters) and many motile forms of life (such as shrimp and crabs) that do not possess swim bladders are remarkably resistant to the blast effects from underwater explosions. Many of these organisms not in the immediate blast area should survive. Benthic organisms would be further protected from the impacts of explosive detonations by the rapid attenuation of the underwater shock wave through the seabed. The shock wave attenuation is significantly less in mud than in the water column, where it is known to impact fish up to 60 m (20 ft) away from a 11.3-kg charge detonated at a 100-m depth (Baxter et al., 1982).

Drilling discharges can affect biological communities and organisms by mechanisms such as the smothering or choking of organisms through deposition of discharged materials and the less obvious sublethal toxicological impacts (e.g., depressed growth and reproduction). During oil and gas drilling operations, the discharged drilling muds and cuttings cause turbidity and literally choke the benthos in proximity to the drill site. Shinn et al. (1993) surveyed an exploratory well site located immediately adjacent to a 4-5 m high pinnacle feature, located at a 103 m depth. Cuttings and drill debris were documented within 6,070 m^2 (1.5 ac) surrounding the drill site. In spite of being inundated by drill muds and cuttings 15 months prior to the investigation, the pinnacle feature was found to support a diverse community, which included gorgonian or soft corals, sponges, non-reef-building corals, a species of horn coral, and abundant meter-long whiplike antipatharians characteristic of tropical hard-bottom communities in water 30 m or more in depth. Shinn et al. (1993) concluded the following: "Gorgonians, antipatharians, crinoids, and non-reef-building corals attached to the pinnacle feature adjacent to the drill site as well as nearby rock bottom did not appear to be affected."

Shinn et al. (1993) acknowledged that their evaluation of the drill site was constrained both by the lack of baseline data on the live-bottom community prior to inundation by drilling discharges and by the need for a study on long-term changes (e.g., 10 years). Continental Shelf Associates (CSA) and Texas A&M University, Geochemical and Environmental Research Group (2001) suggest that recovery of hard-bottom communities following a disturbance will be slow. Hard-bottom communities studied during the recently completed Mississippi/Alabama Pinnacle Trend Ecosystem Monitoring Program exhibits a dynamic sedimentary environment with relatively little net growth of the epibiota associated with the pinnacle features. Additionally, epibiont recruitment studies performed during this same survey showed relatively slow development of fouling community constituents on recruitment plates. Basically, only the earliest successional stages were observed by the end of the study (27 months of exposure), and the epibiota typically associated with nearby hard-bottom features were rare on the plates. It is not known whether the results would have differed if the substrate had consisted of exposed patches of natural hard bottom; however, analysis of larger substrates such as artificial reefs exposed for months to several years also indicates slow community development (Marine Resources Research Institute, 1984). Drilling discharges are still considered to have a deleterious impact on the live-bottom communities of the pinnacle trend, and the stipulation will continue to be applied to minimize the possibility of similar occurrences.

Produced water, described in detail in Chapter 4.1.1.3.4.2, usually contains high amounts of dissolved solids and total organic carbon, and low amounts of dissolved oxygen. Other common components include heavy metals, elemental sulfur and sulfide, organic acids, treating chemicals, and emulsified and particulate crude oil constituents. Salinity of produced water can vary from 0 to 300 ppt. The constituents of produced water have the potential to adversely impact the live-bottom organisms of the pinnacle trend if the constituents reach them in high enough concentrations. Domestic and sanitary wastes originate from sinks, showers, laundries, and galleys, as well as waste water from safety showers, eye-wash stations, and fish-cleaning stations. Human wastes, which contain fecal coliform bacteria, are treated by approved marine sanitation devices prior to discharge. A more complete description of domestic and sanitary wastes can be found in Chapter 4.1.1.3.4.6. The proposed Live Bottom Stipulation would prevent the placement of oil and gas facilities upon the pinnacle trend and live-bottom areas. Consequently, the stipulation prevents the discharge of produced water and domestic and sanitary wastes from occurring directly on top of the live-bottom areas. Dispersion of these wastes should occur rapidly (less than 24 hours) upon discharge.

Proposed Action Analysis

The pinnacles in the CPA are located in the Main Pass and Viosca Knoll lease areas off Mississippi and Alabama within offshore Subareas C0-60 (east of the Mississippi River Delta) and C60-200. Table 4-2 provides information regarding the level of proposal-related activities.

For a CPA proposed action, 77-138 exploration/delineation and development wells and 7-11 production structures are projected for offshore Subareas C0-60 east of the Mississippi River and C60-200. It is unlikely that many of the wells or production structures would be located in the pinnacle trend area, because pinnacle blocks make up only 2 percent of the blocks in Subarea C0-60 (eastern) and 6 percent of the blocks Subarea C60-200. If the Live Bottom Stipulation is implemented, pinnacle features would incur few incidences of anchor damage from support vessels. Furthermore, as noted above, any platforms in this region would be placed so as to avoid pinnacle features for safety reasons. Thus, anchoring events are not expected to impact the resource. Accidental anchor impacts, however, could be extensive, with recovery taking 5-10 years depending on the severity. No such accidents have been recorded to date.

Pipeline emplacement also has the potential to cause considerable disruption to the bottom sediments in the vicinity of the pinnacles (Chapter 4.1.1.3.8.1); however, the implementation of the proposed Live Bottom Stipulation, or a similar protective measure, would restrict pipeline-laying activities as well as oil and gas activities in the vicinity of the pinnacle communities. Data gathered for the Mississippi-Alabama Continental Shelf Ecosystem Study (Brooks, 1991) and the Mississippi/Alabama Pinnacle Trend Ecosystem Monitoring, Final Synthesis Report (Continental Shelf Associates, Inc. and Texas A&M University, Geochemical and Environmental Research Group, 2001) document dense biological communities (i.e., live-bottom communities, fish habitat, etc.) on the high- and medium-relief pinnacle features themselves and live-bottom organisms more sparsely distributed in unconsolidated bottom sediments surrounding the pinnacles. The actual effect of pipeline-laying activities on the biota of the pinnacle communities would be restricted to the resuspension of sediments. The enforcement of the Live Bottom Stipulation will help to minimize the impacts of pipeline-laying activities throughout the pinnacle region. As previously stated, few pipelines in the vicinity of the pinnacle trend are projected to result under a proposed action. The severity of these actions has been judged at the community level to be slight, and impacts from these activities to be such that there would be no measurable interference to the general ecosystem.

Oil and gas operations discharge drilling muds and cuttings that generate turbidity, potentially smothering benthos near the drill sites. Deposition of drilling muds and cuttings in the pinnacle trend area would not greatly impact the biota of the pinnacles or the surrounding habitat. The biota of the seafloor surrounding the pinnacles are adapted to turbid (nepheloid) conditions and high sedimentation rates of the central portion of the pinnacle trend. The pinnacles themselves are coated with a veneer of sediment. Regional surface currents and water depth would largely dilute any effluent. Additional deposition and turbidity caused by a nearby well are not expected to adversely affect the pinnacle environment because such fluids would be discharged into very large volumes of water and would disperse. Mud contaminants measured in the pinnacle trend region reached background levels within 1,500 m of the discharge point (Shinn et al., 1993). Toxic impacts on benthos are limited to within 100 m as a result of the NPDES permit requirements. Such an event would rarely impact the pinnacle trend, live-bottom communities.

The toxicity of the discharged produced waters and domestic and sanitary wastes has the potential to adversely impact the live-bottom organisms of the pinnacle trend; however, as previously stated, the proposed Live Bottom Stipulation would prevent the placement of oil and gas facilities upon (and consequently would prevent the discharge of produced water and domestic and sanitary wastes from occurring directly over) the pinnacle trend, live-bottom areas.

Platform removals have the potential to impact nearby habitats. As previously discussed, the platforms are unlikely to be constructed directly on the pinnacles because of the restraints placed by the Live Bottom Stipulation. Structure removal activities should not deleteriously impact the pinnacle trend area considering the following:

- benthic organisms are resilient to blasts, so only restricted regions would be affected by shock waves from explosives;
- the resuspension of sediments would be limited both in time and space (24 hr for the water column 4 m off the bottom and above, and 7-10 days for the water layer contained in the first 4 m off the seafloor; resuspension of sediments would extend about 1,000 m away from the blasts);

- only a few structures would be removed (2 anticipated removals in the pinnacle area); and
- structures to be removed would have been placed away from any sensitive resources.

It is also anticipated that any damage to the benthic resources of the pinnacle trend area that may occur as a result of structure removals would be followed by a recovery to preinterference conditions within two years.

Summary and Conclusion

Activities resulting from a proposed action in the CPA are not expected to adversely impact the pinnacle trend environment because of implementation of the Live Bottom Stipulation. No community-wide impacts are expected. The inclusion of the Live Bottom Stipulation would minimize the potential for mechanical damage. The impacts of a proposed action are expected to be infrequent because of the few operations in the vicinity of the pinnacles and the small size and dispersed nature of many of the features. Potential impacts from blowouts, pipeline emplacement, mud and cutting discharges, and structure removals would be minimized because of the proposed Live Bottom Stipulation and the low levels of oil and gas activities anticipated in the area. The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features. Impacts from accidents involving anchor placement on pinnacles (those actually crushed or subjected to abrasions) could be severe in a few areas.

Effects of the Proposed Action Without the Proposed Stipulation

Activities resulting from a proposed action without the protection of the proposed Live Bottom (Pinnacle Trend) Stipulation (Chapter 2.3.1.3.2) could have an extremely deleterious impact on portions of the pinnacle trend. Mechanical damage from anchoring, drilling operations, and other activities is potentially the most damaging impact because these activities could destroy biological communities or damage the structure of the pinnacles themselves, reducing the habitat or shelter areas occupied by commercial and recreational fishes. The unevenness of the seafloor associated with the larger pinnacle features would reduce the likelihood that rigs or platforms would be placed directly over a pinnacle. In addition, the pinnacles are widespread throughout the region, so that the potential loss of a few features (or areas within a feature) would cause only slight community-wide impacts on the pinnacle trend as a whole. Because of the low levels of projected OCS activities in the pinnacle trend area and the small size of many features, occurrences of damage would be infrequent. Those areas actually subjected to mechanical disruption would be severely impacted, however. Potential impacts on the pinnacle trend, live-bottom areas from other impact-producing factors associated with OCS activities (pipeline emplacement, discharges of muds and cuttings, explosive structure removals, and oil spills and blowouts) would be infrequent because of the low projected levels of OCS activities. In addition, the widespread occurrence of these pinnacles would further restrain these impacts.

4.2.1.2.2. Topographic Features

The topographic features sustaining sensitive offshore habitats in the CPA are listed and described in Chapter 3.2.2.3. A Topographic Features Stipulation similar to the one described in Chapter 2.3.1.3.1 has been included in appropriate leases since 1973 and may, at the option of the Secretary, be made a part of appropriate leases resulting from this proposal. The impact analysis presented below for a proposed action in the CPA includes the proposed biological lease stipulation. As noted in Chapter 2.3.1.3.1, the stipulation establishes a No Activity Zone within which no bottom-disturbing activities would be allowed and areas around the No Activity Zones (in most cases) within which shunting of drill cuttings and drilling fluids to near the bottom would be required.

The potential impact-producing factors on topographic features of the Central Gulf are anchoring (Chapter 4.1.1.3.2.1), infrastructure emplacement (Chapters 4.1.1.3.1 and 4.1.1.3.2), drilling-effluent and produced-water discharges (Chapter 4.1.1.3.4), and infrastructure removal (Chapter 4.1.1.4). Impacts from oil spills and blowouts are discussed in Chapter 4.4.3.2.2. These disturbances have the potential to disrupt and alter the environmental, commercial (fisheries), recreational, and aesthetic values of topographic features in the CPA.

The anchoring of pipeline lay barges, drilling rigs, or service vessels, as well as the emplacement of structures (e.g., pipelines, drilling rigs, or production platforms), results in mechanical disturbances of the benthic environment. Anchor damage has been shown to be the greatest threat to the biota of the offshore banks in the Gulf (Bright and Rezak, 1978; Rezak et al., 1985). Such anchoring damage, however, would be prevented within any given No Activity Zone by the observation of the Topographic Features Stipulation.

Infrastructure emplacement and pipeline emplacement are other oil and gas activities that could resuspend sediments. The proposed stipulation would also prevent these activities from occurring in the No Activity Zone, thus preventing most of these resuspended sediments from reaching the biota of the banks.

Considering the relatively elevated amounts of drilling muds and cuttings discharged per well (10,542 bbl/exploratory well; 7,436 bbl/development well) (USEPA, 1993a and b), potential impacts on biological resources of topographic features should be expressly considered if drill sites occur in blocks directly adjacent to No Activity Zone boundaries (Topographic Features Stipulation). Potential impacts could be incurred through increased water-column turbidity, the smothering of sessile benthic invertebrates, and local accumulations of contaminants. The USEPA general NPDES permit sets special restrictions on discharge rates for muds and cuttings adjacent to topographic features bound by a No Activity Zone. Chapters 4.1.1.3.4 and 4.2.1.3.2 detail the NPDES permit's general restrictions and the impacts of drilling muds and cuttings on marine water quality and seafloor sediments. The levels and areal extent of discharged contaminants measured in the water column or sediments will be reduced from levels and extent measured in the past because current USEPA regulations and NPDES permits contain more restrictive limits (Chapter 4.2.1.3.2). The effects of past muds and cutting discharges are also discussed in Chapter 4.2.1.3.2. A brief overview of the potential impacts on topographic features by drilling discharges follows.

Water-column turbidity and the smothering of sessile invertebrates on topographic features caused by drilling muds and cuttings are of little significance for two reasons. First, the Topographic Features Stipulation limits impact through the No Activity Zone shunting restrictions imposed within the 1-Mile Zone and 1,000-Meter Zone, as well as the USEPA general NPDES permit special restrictions on discharge rates in blocks adjacent to a No Activity Zone or sensitive areas, which necessitates photodocumentation by industry. Secondly, studies have shown the rapid dispersion of drilling fluid plumes in the OCS within a 1,000-m range of the discharge point and the resilience of sessile invertebrates exposed or smothered with an extreme range of concentrations of drilling muds (Kendall, 1983). For local accumulation of contaminants, assumptions are that trace-metal and petroleum contamination resulting from drilling muds and cuttings will occur mainly within a few hundred to a couple of thousand meters downcurrent from the discharge point and can be found up to 3,000 m downcurrent in shallow waters. Concentrations of contaminants decrease with an increasing distance from the drilling site. By examining sediments surrounding three gas production platforms (within a 100-m radius), Kennicutt et al. (1996) found low concentrations of petroleum and trace metal contaminants that would unlikely induce a biological response in benthic organisms. The highest trace metal concentrations originating from discharged drilling fluids and found around platforms were strongly correlated with the presence of sand-size sediments. Shallow sites are subject to comparatively greater sediment removal and resuspension due to a high-energy environment. Contaminants from previous discharges under less restrictive conditions have been found to remain in sediments surrounding drill sites for as long as 10 years (Kennicutt et al., 1996). Toxic effects could be incurred by benthic organisms on topographic features found in the vicinity of a No Activity Zone boundary if the plume flow of an operation is consistently directed toward that boundary. Should effects occur, they would potentially persist for as long as 10 years following the onset of discharges.

Produced waters could also represent a significant potential source of impact to the biota of topographic features, considering produced water constitutes the largest single discharge during routine oil and gas operations. The USEPA general NPDES permit restrictions on the discharge of produced water help to limit the impacts on biological resources of topographic features. Past evaluation of the bioaccumulation of offshore produced-water discharges conducted by the Offshore Operators Committee (1997) assessed that metals discharged in produced water would, at worst, affect living organisms found in the immediate vicinity of the discharge, particularly those attached to the submerged portion of platforms. Naturally occurring radioactive material in produced water was not found to bioaccumulate in marine animals (2 species of molluscs and 5 species of fish). Because high-molecular, polycyclic aromatic hydrocarbons (PAH's) are usually in such dilute concentrations in produced water, they pose little threat to marine organisms and their constituents, and were not anticipated to biomagnify in marine food webs. Monocyclic hydrocarbons and other miscellaneous organic chemicals are known to be moderately toxic, but they do not bioaccumulate to high concentrations in marine organisms and are not known to pose a risk to their consumers. A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in Chapter 4.2.1.3.

The impacts of structure removal on topographic features can include water turbidity, sediment deposition, and explosive shock-wave impacts. Both explosive and nonexplosive removal operations would disturb the seafloor by generating considerable turbidity. The deposition of resuspended sediments would occur much in the same manner as discussed for discharges of muds and cuttings, choking and causing mortality of sessile benthic organisms. Turbidity could both reduce light levels and obstruct filter-feeding mechanisms, leading to reduced productivity, susceptibility to infection, and mortality. The shock waves produced by the explosive structure removals could also harm associated biota. Corals and other sessile invertebrates have a supposedly high resistance to shock. O'Keeffe and Young (1984) described the impacts of underwater explosions on various forms of sea life using, for the most part, open-water explosions much larger than those used in typical structure removal operations. They found that sessile benthic organisms, such as barnacles and oysters, and many motile forms of life, such as shrimp and crabs, that do not possess swim bladders were remarkably resistant to shock waves generated by underwater explosions. Oysters located 8 m away from the detonation of 135-kg charges in open water incurred a 5 percent mortality. Crabs distanced 8 m away from the explosion of 14-kg charges in open water had a 90 percent mortality rate. Few crabs died when the charges were detonated 46 m away. O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods." Benthic organisms appear to be further protected from the impacts of subbottom explosive detonations by rapid attenuations of the underwater shock wave traversing the seabed away from the structure being removed. The shock-wave attenuation is significantly less in mud than in the water column where it is known to impact fish up to 60 m away from a 11.3-kg charge blasted at a 100-m depth (Baxter et al., 1982). Theoretical predictions suggest that the shock waves of explosives set 5 m below the seabed as required by MMS regulations would further attenuate blast effects. Charges used in OCS structure removals are typically much smaller than some of those cited by O'Keeffe and Young. The *Programmatic Environmental Assessment for Structural Removal Activities* (USDOI, MMS, 1987) predicts low impacts on the sensitive offshore habitats from platform removal precisely because of the effectiveness of the proposed stipulation in preventing platform emplacement in the most sensitive areas of the topographic features of the Gulf of Mexico. Impacts on the biotic communities, other than those on or directly associated with the platform, would be conceivably limited by the relatively small size of individual charges (normally 22.7 kg or less per well piling and per conductor jacket) and by the fact that charges are detonated 5 m below the mudline and at least 0.9 seconds apart (timing needed to prevent shock waves from becoming additive). The stipulation discussed above would preclude platform installation in the No Activity Zone, thus preventing adverse effects from nearby removals.

Proposed Action Analysis

All of the 16 topographic features (shelf edge banks, mid-shelf banks, and low-relief banks) in the CPA are found in waters less than 200 m deep. They represent a small fraction of the Central Gulf area.

As noted above, the proposed Topographic Features Stipulation could prevent most of the potential impacts from oil and gas operations on the biota of topographic features, including direct contact during pipeline, rig, and platform emplacements and anchoring activities. Yet, operations outside the No Activity Zones could still affect topographic features through drilling-effluent and produced-water discharges, blowouts, and oil spills. Potential impacts from oil spills and blowouts are discussed in Chapter 4.4.3.2.2.

For a CPA proposed action, 181-312 exploration/delineation and development wells are projected for offshore Subareas C0-60 and C60-200. With the inclusion of the proposed Topographic Features Stipulation, no discharges would take place within the No Activity Zones. Drilling discharges would be shunted to within 10 m of the seafloor either within a radius of 1,000 m, 1 mi (1,609 m), 3 mi (4,828 m), or 4 mi (6,437 m) (depending on the topographic feature) around the No Activity Zone. This procedure would essentially prevent the threat of large amounts of drilling effluents reaching the biota of a given topographic feature. It has been estimated, however, that drilling effluents and produced waters could reach and impact topographic features 5-10 times during the life of this proposal. The severity of such impacts would probably be primarily sublethal such that there may be a disruption or impairment of a few elements at the regional or local scale, but no interference to the general system performance. Recovery to pre-impact conditions should take place within 2 years.

For a CPA proposed action, 23-39 production structures are projected in offshore Subareas C0-60 and C60-200. Between 11 and 20 structure removals using explosives are projected for Subarea C0-60 and between 2 and 4 for Subarea C60-200. The explosive removals of platforms should not impact the biota of topographic features because the Topographic Features Stipulation restricts the emplacement of platforms to locations most certainly farther than 100 m away from No Activity Zone boundaries. This emplacement would prevent shock-wave impacts and resuspended sediments from reaching the biota of topographic features.

Summary and Conclusion

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live-bottom communities from bottom-disturbing activities (structure removal and emplacement) and operational discharges. Recovery from impact incidences of operational discharges would take place within 10 years.

Effects of the Proposed Action Without the Proposed Stipulation

The topographic features and associated coral reef biota of the Central Gulf could be adversely impacted by oil and gas activities resulting from a proposed action should they be unrestricted by the absence of the proposed Topographic Features Stipulation. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected Central Gulf topographic features.

The No Activity Zone would probably be the area of the topographic features most susceptible to adverse impacts if oil and gas activities are unrestricted by the Topographic Feature Stipulation and not followed up by mitigating measures. These impacting activities could include vessel anchoring and infrastructure emplacement, discharges of drilling muds and cuttings, and ultimately the explosive removal of structures. All of the above-listed activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone. In most cases, recovery from disturbances would take 10 years or more. Long-lasting and possibly irreversible change would be caused mainly by vessel anchoring and structure emplacement (pipelines, drill rigs, and platforms). Indeed, such activities would physically and mechanically alter benthic substrates and their associated biota over areas, possibly ranging from tens to thousands of square meters per impact. Operational discharges would cause substantial and prolonged turbidity and sedimentation, possibly impeding the well-being and permanence of the biota and causing the decrease of live benthic cover.

Finally, the unrestricted use of explosives to remove platforms installed in the near vicinity of or on the topographic features could cause turbidity, sedimentation, and shock-wave impacts that would affect reef biota.

The shunting of cuttings and fluids, which would be required by the Topographic Features Stipulation, is intended to limit the smothering and crushing of sensitive benthic organisms by depositing the foreign substances in areas where they could not be displaced by currents onto the topographic features. The impacts from unshunted exploration and development discharges of drill cuttings and drilling fluids within the 1,000-Meter Zone and the 1-Mile Zone would definitely impact the biota of topographic features. Specifically, the discharged materials would cause prolonged events of turbidity and sedimentation, which could have long-term deleterious effects on local primary production, predation, and consumption by benthic and pelagic organisms, biological diversity, and benthic live cover. The unrestricted discharge of drilling cuttings and fluids during development operations within the 3-Mile Zone would be a further source of impact to the sensitive biological resources of the topographic features.

Therefore, in the absence of the Topographic Features Stipulation, a proposed action could cause long-term (10 years or more) adverse impacts to the biota of the topographic features, located in most cases on those portions of the topographic features that are in 85 m and less water depth.

4.2.1.2.3. Chemosynthetic Deepwater Benthic Communities

Physical

The greatest potential for adverse impacts on deepwater chemosynthetic communities would come from those OCS-related, bottom-disturbing activities associated with pipelaying (Chapter 4.1.1.3.8.1), anchoring (Chapter 4.1.1.3.2.1), and structure emplacement (Chapter 4.1.1.3.1), as well as from an accidental seafloor blowout (Chapter 4.4.1.2). Potential impacts from blowouts are discussed in Chapter 4.4.3.2.2. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area.

Considerable mechanical damage could be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affect a small area of the sea bottom. The presence of a conventional structure can also cause scouring of the surficial sediments by near-bottom ocean currents (Caillouet et al., 1981), although this phenomena has not been demonstrated around structures in deep water.

Anchors from support boats and ships (or, as assumed for deeper water depths, from any buoys set out to moor these vessels), floating drilling units, barges used for construction of platform structures, and pipelaying vessels also cause severe disturbances to small areas of the seafloor. The areal extent and severity of the impact are related to the size of the mooring anchor and the length of chain resting on the bottom. Excessive scope and the movement of the mooring chain could disturb a much larger bottom area than an anchor alone, depending on the variety of prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy chemosynthetic communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the central drilling structure. Larger anchors, longer anchor chains/cables and mooring lines, and greater scope for anchoring configurations are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, are expected to be greater for operations that employ anchoring in deep water. Many oil and gas support operations involving ships and boats would not result in anchor impacts on deepwater chemosynthetic communities because the vessels would tie-up directly to rigs, platforms, or mooring buoys. In addition, there are drillships, construction barges, and pipelaying vessels operating in the Gulf of Mexico that rely on dynamic positioning rather than conventional anchors to maintain their position during operations (anchoring would not be a consideration in these situations). The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and current. Anchoring will destroy those sessile organisms actually hit by the anchor or anchor chain during anchoring and anchor weighing, or it could cause destruction of underlying carbonate structures on which organisms rely for dispersion of hydrocarbon sources. While such an area of disturbance may be small in absolute terms, it may be large in relation to the area inhabited by dense chemosynthetic communities.

Normal pipelaying activities in deepwater areas could destroy large areas of chemosynthetic organisms (it is assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed). Since pipeline systems are not as established in deepwater as in shallow water, new installations are required, which will tie into existing systems or bring production directly to shore. Pipelines will also be required to transport product from subsea systems to fixed platforms.

In addition to physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cutting discussed below.

The impacts from bottom-disturbing activities are expected to be relatively rare. Should they occur, these impacts could be quite severe to the immediate area affected, with recovery times as long as 200 years for mature tube-worm communities, with the possibility of the community never recovering.

Discharges

In deep water, discharges of drilling fluids and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Recent information about the effects of surface discharge of drilling fluids (muds) and cuttings at a well in 565 m have been reported by Gallaway and Beaubien (1997). In this instance, a veneer of cuttings was observed scattered over the bottom, in some cases as thick as 20-25 cm. Chemical evidence of SBF components (used during this operation) was found at distances of at least 100 m from the well site (sampling distance was limited by the ROV tether length). Other information from a geophysical survey documented the extent of drilling discharges at several previously drilled oil and gas sites in about 400 m water depths (Nunez, personal communication, 1994). At these sites, the areal coverage of cuttings was found extending from the previous well locations in splay or finger-like projections to a maximum of about 610 m, with an average of about 450 m. An examination of side-scan-sonar records of these splays indicates that they were distributed in accumulations less than 30 cm thick. Effluents from routine OCS operations (not muds or cuttings) in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m.

Impacts from muds and cuttings are also expected from two additional sources: (1) initial well drilling and installation of casing prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various dual-gradient or subsea mudlift drilling techniques in the deep sea. Pre-riser casing installation typically involves 36-in (91-cm) casing that may be set to a depth of 300 ft (91 m) and 26-in (66-cm) casing that may be set to a depth of 1,600 ft (488 m). Jetted or drilled cuttings from the initial wellbore could total as much as 226 m^3 (Halliburton Company, 1995). With dual-gradient drilling techniques, the upper portion of the wellbore will be "drilled" similar to conventional well initiation techniques with cuttings being discharged at the seafloor. After the BOP stack is installed, subsea mudlift pumps will circulate the drilling fluid and cuttings to the surface for conventional well solids control. Discharges from the dual-gradient drilling operations are expected to be similar to conventional drilling operations. Although the full areal extent and depth of burial from these initial activities are not known, the potential impacts are expected to be localized and short term. Since these areas would occupy a minuscule portion of the available seafloor in the deepwater Gulf of Mexico, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

MacDonald et al. (1995) indicates that the vulnerability of chemosynthetic communities to oil and gas impacts may depend on the type of community present. Tube-worm and mussel communities may be more vulnerable than clam communities because clam communities are vertically mobile (preventing burial) and sparsely distributed. The primary concern related to muds and cuttings discharges is that of burial. Although chemosynthetic organisms thrive with some part of their anatomy located next to or inside of toxic and/or anoxic environments, all chemosynthetic biota (including the symbiotic bacteria) also require oxygen to live. Burial by sediments or rock fragments originating from drilling fluids and cuttings discharges would smother and kill most chemosynthetic organisms (motile clams being one possible exception). Depending on the organism type, just a few centimeters of burial could cause mortality.

The tolerance of various community components to burial is not completely understood and would depend on the depth of burial. Detrimental effects due to burial are expected to decrease exponentially in the same manner that the depth of accumulations of discharges decrease exponentially with distance from the origin. The severity of these impacts is such that there may be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

High-density, Bush Hill-type communities are areas that are considered to be most at risk from oil and gas operations. The disturbance of a Bush Hill-type environment could lead to the destruction of a community from which recovery would occur only over long time intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or would not occur at all. A long span of time is required for the precipitation of enough carbonate rock to support a large population of tube worms. As dense tube-worm communities require hard substrate as well as very active seepage at any point in space, existing communities covered by sediment that are physically damaged would likely never recover (Fisher, 1995).

Information is limited about the vulnerability of tube worms to sedimentation/smothering impact. Individual tube worms are often found buried for more than half the length of their tubes by hemipelagic sediment (MacDonald, 1992). Presumably, this burial occurs over long time intervals. Evidence of catastrophic burial of high-diversity chemosynthetic communities can be found in the paleorecord as documented by Powell (1995), but the importance of this in causing local extinctions was reported as minor. These burials were probably caused by catastrophic seismic events.

Methanotrophic mussel communities have strict chemical requirements that tie them directly to areas of the most active seepage. Physical disturbance of an active mussel bed is thought not to have a long-lasting effect on the community due to high growth rates of individuals (Fisher, 1995). Catastrophic mud burial would be one possible cause of a mussel community death. It is predicted that a mussel community completely eliminated by physical disturbance could be resettled and mature within 20 years.

Reservoir Depletion

There has been some speculation about the potential impact to chemosynthetic communities as a result of oil and gas withdrawal, causing a depletion of the energy source (hydrocarbons) sustaining the chemosynthetic organisms. There is evidence that both removal and reinjection of material into reservoirs that supply seeps on land in California affect the seepage rates. Quigley et al. (1996) reported evidence that suggested offshore California oil production resulted in reduced seepage due to reduction in reservoir pressure. The seeps and faults around which chemosynthetic animals live are supplied from the deep reservoirs that transport the gas or oil to the seafloor through combined effects of buoyancy and pressure. When all of the recoverable hydrocarbons from these reservoirs are withdrawn by production operations (the amount that can be economically extracted by current technology is estimated to be 30% or less of the total hydrocarbons), it is possible that oil and gas venting or seepage would also slow or (less likely) stop. Based on current information, it is not possible to determine whether reduced reservoir pressure would actually reduce the seepage (as observed onshore) or whether there may be enough oil already in the conduit to the surface to continue adequate levels of seepage for long periods, perhaps thousands of years or more. The distribution of chemosynthetic communities is known to occur in association with precise levels and types of chemical gradients at the seafloor; alterations to these gradients may potentially impact the type and distribution of the associated community.

Proposed Action Analysis

Because high-density chemosynthetic communities are generally found only in water depths greater than 400 m, they would not be found in shallow-water areas of the CPA (Subareas C0-60 or C60-200, Table 4-2). Chemosynthetic communities could be found in the deeper water areas (Subareas C200-800, C800-1600, C1600-2400 and C>2400, Table 4-2). Of the 45 known communities, a total of 26 documented chemosynthetic communities are known to exist in the CPA: 1 in the Viosca Knoll lease area; 2 in the Ewing Bank lease area; 1 in the Mississippi Canyon lease area; and 22 in the Green Canyon lease area. The levels of projected impact-producing factors for deepwater Subareas C200-800, C800-1600, C1600-2400 and C>2400 are shown in Table 4-2. A range of 5-10 oil and gas production structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2003 and 2042 in the deepwater portions of the CPA as a result of a proposed action. These deepwater production structures are expected to be installed between 5 and 20 years after a proposed lease sale, with a peak annual installation rate of 2-3.

Notice to Lessees (NTL) 98-11(superseded by NTL 2000-G20) has been a measure for the protection of chemosynthetic communities since February 1, 1989. Now, NTL 2000-G20 makes mandatory the search for and avoidance of dense chemosynthetic communities (such as Bush Hill-type communities) or areas that have a high potential for supporting these community types, as interpreted from geophysical records. The NTL is exercised on all applicable leases and is not an optional protective measure. Under the provisions of this NTL, lessees operating in water depths greater than 400 m are required to conduct geophysical surveys of the area of proposed activities and to evaluate the data for indications of conditions that may support chemosynthetic communities; if such conditions are indicated, the lessee must either move the operation to avoid the potential communities or provide photodocumentation of the presence or absence of dense chemosynthetic communities of the Bush Hill type. If such communities are indeed present, no drilling operations or other bottom-disturbing activities may take place in the area;

if the communities are not present, drilling, anchoring, etc. may proceed. To date, in almost all cases, operators have chosen to avoid any areas that show the potential to support chemosynthetic communities. The basic assumptions underlying the provisions of this mitigation measure are (1) that dense chemosynthetic communities are associated with gas-charged sediments or seeps, (2) that the gas-charged sediment zones or seeps have physical characteristics that will allow them to be identified by geophysical surveys, and (3) that dense chemosynthetic communities are not found in areas where gas-charged sediments or seeps are not indicted on the geophysical survey data. These assumptions have not been totally verified. A definitive correlation between the geophysical characteristics recorded by geophysical surveys and the presence of chemosynthetic communities has not been proven.

Although there are few examples of field verification, the requirements set forth in NTL 2000-G20 are considered effective in identifying potential areas of chemosynthetic communities. Although there has generally been compliance with NTL 2000-G20, compliance does not guarantee avoidance of high-density communities without visual confirmation in every case. On rare occasions, high-density chemosynthetic community areas may not be properly identified using the geophysical systems and indicators specified in the existing NTL. Oil- or gas-saturated sediments and other related characteristic signatures cannot be determined without high-resolution acoustic records or the interpretation of subsurface 3D seismic data.

Improved definitions and avoidance distances have been released in a new Chemosynthetic Community NTL 2000-G20. Requirements for specific separation distance between potential high-density chemosynthetic communities and both anchors (250-500 ft) and drilling discharge points (1,500 ft) have been included in the revision of the NTL. These new guidelines have also been released in the new Interim Plans NTL (NTL 2000-G10), which became effective May 31, 2000. The potential for any impact could also be lessened by the refinement of techniques used in the interpretations of geophysical records. The use of differential global positioning system (GPS) has also been required on anchor handling vessels when placing anchors near an area that has potential for supporting chemosynthetic communities. As new information becomes available, the NTL will be further modified as necessary.

High-density, Bush Hill-type communities are, as noted above, largely protected from direct physical impacts by the provisions of NTL 2000-G20. A limited number of these communities have been found to date, but it is probable that additional communities exist. Observations of the surface expression of seeps from space images indicate numerous other communities may exist (MacDonald et al., 1993 and 1996). Most chemosynthetic communities are of low density and are relatively widespread throughout the deepwater areas of the Gulf. Physical disturbance or destruction of a small, low-density area would not result in a major impact to chemosynthetic communities as an ecosystem. Low-density communities may occasionally sustain major or minor impacts from discharges of drill muds and cuttings, bottom-disturbing activities, or resuspended sediments. Areas so impacted could be repopulated from nearby undisturbed areas (although this process may be quite slow, especially for vestimentiferans). In light of probable avoidance of all chemosynthetic communities (not just high-diversity types) as required by NTL 2000-G20, the frequency of such impact is expected to be low, and the severity of such an impact is judged to result in minor disturbance to ecological function of the community, with no alteration of ecological relationships with the surrounding benthos. Recolonization after a disturbance would not exactly reproduce the preexisting community prior to the impact, but it could be expected that some similar pattern and species composition would eventually reestablish if similar conditions of sulfide or methane seepage persist after the disturbance.

Summary and Conclusion

Chemosynthetic communities are susceptible to physical impacts from structure placement (including templates or subsea completions), anchoring, and pipeline installation. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

If the presence of a high-density community were missed using existing procedures, potentially severe or catastrophic impacts could occur due to raking of the sea bottom by anchors and anchor chains and partial or complete burial by muds and cuttings associated with pre-riser discharges or some types of riserless drilling. Variations in the dispersal and toxicity of synthetic-based drilling fluids may contribute to the potential areal extent of these impacts. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment.

A proposed action in the CPA is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments located at more than 1,500 ft away as required by NTL 2000-G20.

4.2.1.2.4. Nonchemosynthetic Deepwater Benthic Communities

Physical

Benthic communities other than chemosynthetic organisms could be impacted by OCS-related, bottom-disturbing activities associated with pipelaying (Chapter 4.1.1.3.8.1.), anchoring (Chapter 4.1.1.3.2.1), and structure emplacement (Chapter 4.1.1.3.1), as well as from a seafloor blowout (Chapter 4.4.1.4). Potential impacts from blowouts are discussed in Chapter 4.4.3.2.2. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area. Considerable mechanical damage can be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affects a small area of the sea bottom. These impacts are the same as those encountered in shallower continental shelf waters.

Anchors from support boats and ships (or, as assumed in these water depths, from any buoys set out to moor these vessels), floating drilling units, and pipelaying vessels also cause severe disturbances to small areas of the seafloor with the areal extent related to the size of the mooring anchor and length of chain that would rest on the bottom. Excessive scope (length) and movement of the mooring chain could disturb a much larger area of the bottom than would an anchor alone, depending on the prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the central drilling structure. Larger anchors and additional scope of anchor chain are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, are expected to be greater for operations that employ anchoring in deep water. The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and current. (Many OCS-support operations and activities will not result in anchor impacts to deepwater benthic communities because vessels will tie-up directly to rigs, platforms, or mooring buoys or will use dynamic positioning.) Anchoring will not necessarily directly destroy small infaunal organisms living within the sediment; the bottom disturbance would most likely change the environment to such an extent that the majority of the directly impacted infauna community would not survive (e.g., burial or relocation to sediment layers without sufficient oxygen). In cases of carbonate outcrops or reefs with attached epifauna, the impacted area of disturbance may be small in absolute terms, but it could be large in relation to the area inhabited by hard corals or other organisms that rely on exposed rock substrate.

As described in the previous section for chemosynthetic communities, normal pipelaying activities in deepwater areas could destroy large areas of benthic communities (it is assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed.); although, without consideration of chemosynthetic organisms, there are no differences between this activity in deep water as compared to shallow-water operations.

In addition to direct physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cuttings discussed below.

Discharges

In deep water, discharges of drilling muds and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Recent information about the effects of surface discharge of muds and cuttings at a well in 565 m is reported by Gallaway and Beaubien (1997) and is described in the previous section on chemosynthetic communities. In this instance and in another deepwater survey reported by Nunez (personal communication, 1994), muds and cuttings were documented in accumulations ranging up to 30 cm thick at distances up to 610 m from the well site.

Impact from muds and cuttings are also expected from two additional sources: (1) initial well drilling prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various riserless drilling techniques in the deep sea. Jetted or drilled cuttings discharged at the bottom from the initial wellbore would total as much as 226 m^3 (Halliburton Company, 1995). In the case of some riserless drilling practices, all muds and cuttings from well spudding through total depth would be discharged at the seafloor. Although the full areal extent and depth of burial from these activities is not known, the potential impacts are expected to be localized and short term. Since these areas would occupy only a minuscule portion of the available seafloor in the deepwater Gulf of Mexico, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

Burial by sediments or rock fragments originating from drilling muds and cuttings discharges could smother and kill almost all community components of benthic organisms, with the exception of highly motile fish and possibly some crustaceans such as shrimp capable of moving away from the impacted area. Depending on the organism type, just a few centimeters of burial could cause death. The damage would be both mechanical and toxicological. Some types of macrofauna could burrow through gradual accumulations of overlying sediments depending on the toxicological effects of those added materials. Information on the potential toxic effects on various benthic organisms is limited and essentially nonexistent for deepwater taxa.

It can be expected that detrimental effects due to burial would decrease exponentially with distance from the origin. The physical properties of the naturally occurring surface sediment (grain size, porosity, and pore water) could also be changed as a result of discharges such that recolonizing benthic organisms would be comprised of different species than inhabited the area previous to the impact. Although the impacts could be considered severe to the nonmotile benthos in the immediate area affected, they would be considered very temporary. Due to the proximity of undisturbed bottom with similar populations of benthic organisms from microbenthos to megafauna, these impacts would be very localized and reversible at the population level and are not considered significant.

Carbonate outcrops not associated with chemosynthetic communities, such as the deepwater coral "reef" or habitat reported by Moore and Bullis (1960), are considered to be most at risk from oil and gas operations. Due to the fact that deepwater corals require hard substrate, existing communities completely buried by some amount of sediment would likely never recover.

Effluents other than muds or cuttings from routine OCS operations in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m.

Proposed Action Analysis

For a proposed action in the CPA, 5-10 oil and gas structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2001 and 2040 in Subareas C200-800, C800-1600, C1600-2400, and C>2400 (Table 4-2). These deepwater production structures are expected to be installed 5-10 years after a proposed lease sale, with a peak annual rate of 1-2. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms, such as brittle stars, sea pens, or crabs, would not result in a major impact to the deepwater benthos ecosystem as a whole. Surface discharge of muds and cuttings, as opposed to seafloor discharge, would reduce or eliminate the impact of smothering the benthic communities on the bottom.

Under the current review procedures for chemosynthetic communities, carbonate outcrops are targeted as one possible indication (surface anomaly on 3D seismic survey data) that chemosynthetic seep communities are nearby. Unique communities that may be associated with any carbonate outcrops or other topographical features could be identified via this review along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a geological hazard for any well sites. Any proposed activity in water depth greater than 400 m would automatically trigger the NTL 2000-G20 evaluation described above.

Summary and Conclusion

Some impact to benthic communities from drilling and production activities would occur as a result of physical impact from structure placement (including templates or subsea completions), anchoring, and installation of pipelines regardless of their locations. Megafauna and infauna communities at or below the sediment/water interface would be impacted from the muds and cuttings normally discharged at the seafloor at the start of every new well prior to riser installation. The impact from muds and cuttings discharged at the surface are expected to be low in deep water. Drilling muds would not be expected to reach the bottom beyond a few hundred meters from the surface-discharge location, and cuttings would be dispersed. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be very rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts from OCS activities. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate.

A proposed action in the CPA is expected to cause little damage to the ecological function or biological productivity of the widespread, typical deep-sea benthic communities.

4.2.1.3. Impacts on Water Quality

Activities that are projected to result from a single lease sale in the CPA are given in Table 4-2. The routine activities that will impact water quality include the following:

- discharges during drilling of exploration and development wells;
- workover of a well;
- structure installation and removal;
- discharges during production;
- installation of pipelines;
- service vessel discharges; and
- discharges from support facilities.

The current NPDES General Permit for OCS discharges in USEPA Regions 4 (eastern CPA and EPA) and 6 (WPA and western CPA) will expire in October 2003 and April 2004, respectively.

4.2.1.3.1. Coastal Waters

Proposed Action Analysis

In coastal waters, the water quality will be impacted by the discharges from the service vessels in port. The types of discharges and regulations were discussed in Chapters 4.1.1.3.4.8 and 4.1.2.1.10.2. Most discharges are treated prior to release, with the exception of ballast water. In coastal waters, bilge water may be discharged with an oil content of 15 ppm or less. The discharges will affect the water quality locally. Estimates of the volume of bilge water that may be discharged are not available.

Supporting infrastructure also discharge into local waterways during routine operations. The types of onshore facilities are discussed in Chapter 4.1.2.1.10.1. All point-source discharges are regulated by the USEPA, which is the agency responsible for coastal water quality. The USEPA NPDES storm-water effluent limitations regulate storm-water discharges from supporting facilities. Nonpoint source run-off, such as rainfall that has drained from a public road, may contribute hydrocarbon and trace-metal pollutants. Data are not available to make estimates of the impact from nonpoint-source discharges.

The dredging of navigation channels and the installation of pipelines will result in a temporary increase in the suspended sediment load.

Summary and Conclusion

The primary impacting sources to water quality in coastal waters are point-source and nonpoint-source discharges from support facilities and vessel discharges. The impacts to coastal water quality from a proposed action in the CPA should be minimal as long as all regulatory requirements are met.

4.2.1.3.2. Marine Waters

Proposed Action Analysis

Drilling Muds and Cuttings

The primary effects on water quality during the drilling of exploratory and development wells result from the discharges of drilling fluids, called "muds," and cuttings. Table 4-9 gives estimated volumes of muds and cuttings that may be discharged from drilling of an "average" well. The MMS estimates that each lease sale in the CPA will result in 111-247 exploratory and delineation wells and 178-352 development wells being drilled over 35 years. Using the data in Table 4-9, discharges of 1,000,000-2,300,000 bbl of water-based drilling fluids (WBF) and 160,000-330,000 bbl of associated cuttings are estimated from drilling these wells. The direct discharge of synthetic-based drilling fluids (SBF) is prohibited; however, some fluid adheres to the cuttings and an estimated 70,000-150,000 bbl of SBF may be discharged with the estimated 60,000-130,000 bbl of SBF-associated cuttings.

Drill cuttings deposited on the seafloor are representative of the geological formations below the seafloor. The cuttings will include clastic (e.g., sand, silt, and clay), carbonate (e.g., limestone), and evaporite (e.g., salt) rock fragments. They may contain a variety of naturally occurring metals. Silicon, aluminum, iron, and calcium are typically abundant in cuttings, while elements such as cadmium, vanadium, and mercury are found in trace quantities. These elements are unlikely to leach from cuttings into water in any appreciable amounts because they are chemically bound within the rock minerals and therefore not available for biological assimilation. Of environmental concern is the physical impact of the cuttings deposition to the benthic habitat and the potential toxicity of drilling fluid adhered to the cuttings.

The fate and effects of WBF have been extensively studied throughout the world (Engelhardt et al., 1989). The primary concerns for WBF are the increased turbidity in the water column, alteration of sediment characteristics because of coarse material in cuttings, and trace metals. Occasionally, formation fluids may be discharged with the cuttings, adding hydrocarbon contamination. The WBF are rapidly dispersed in the water column immediately after discharge, and the solids descend to the seafloor (Neff, 1987). The greatest effects to the benthos are within 100-200 m, primarily due to the increased coarsening of the sediment by cuttings. Most of the components of the WBF have low toxicity with the exception of some trace metals. Barium is the major element in the mud because of the high barite level, but trace amounts of chromium, copper, cadmium, mercury, lead, and zinc are also present. Significant elevations of all these metals except chromium were observed within 500 m of six Gulf of Mexico drilling sites on the continental shelf (Boothe and Presley, 1989). The USEPA guidelines limit the levels of cadmium and mercury in stock barite to 3.0 milligrams/kilogram (mg/kg) and 1.0 mg/kg (dry weight), respectively. A study of chronic impacts from oil and gas activities (Kennicutt, 1995) determined that metals from discharges, including mercury and cadmium, were localized to within 150 m of the structure. Highest levels of metal contaminants were attributed to a platform where discharges are shunted to within 10 m of the bottom.

A recent literature review (Neff et al., 2000) discusses the current knowledge about the fate and effects of SBF on the seabed. Like oil-based drilling fluids (OBF), the SBF do not disperse in the water column and therefore are not expected to adversely affect water quality. They do, however, settle very close to the discharge point, thus affecting the local sediments. Unlike OBF, the SBF do not typically contain toxic aromatic compounds. The primary affects are smothering, alteration of grain size, and addition of organic matter, which can result in localized anoxia while the SBF degrade. Different formulations of SBF use different base fluids that degrade at different rates, thus affecting the impact. The SBF cuttings could pass the current discharge criterion for WBF because of their low toxicity. Bioaccumulation tests also indicate that SBF and their degradation products should not significantly bioaccumulate. It is expected that discharged cuttings should degrade within 2-3 years after cessation of discharge. The MMS is currently jointly funding a study of the spatial and temporal effects of discharged cuttings to evaluate the effects. In deep water (>400 m), the use of dual density drilling techniques may result in the discharge of cuttings at the seafloor. The cuttings will not have undergone any cleaning process to remove the drilling fluids, and the impacts of these discharges are not known.

Produced Water

During production, produced water is the primary discharge and will impact water quality by adding hydrocarbons and trace metals to the environment. As discussed in Chapter 4.1.1.3.4.2, the volume of produced water from a facility ranges from 2 to 150,000 bbl/day. With a monthly average of 29 milligrams/liter (mg/l), the volume of added hydrocarbons would be 5.8×10^{-5} bbl/day. As a result of a single lease sale in the CPA, MMS estimates that 28-49 production structures will be installed (Table 4-2). Examination of historical data for produced water extracted from blocks in the Gulf of Mexico (Table 4-10) demonstrates that, on average for the past five years, 7,580 bbl of produced water are generated per block per year. As can be seen in Figure 4-3, most of the produced water is extracted in the CPA. Assuming that each production structure produces an average of 7,580 bbl/yr of water and the discharge averages 29 mg/l hydrocarbon content, then approximately 0.2-0.3 bbl/yr of hydrocarbons are added to the environment from each structure. This amount is negligible relative to natural sources of hydrocarbons. Discharges from workovers and other activities are generally mixed with the produced water and therefore must meet the same criteria.

Several studies have been conducted to evaluate the effects of produced-water discharges from platforms on the surrounding water column, sediments, and biota (e.g., Rabalais et al., 1991; Kennicut, 1995; CSA, 1997b). The GOOMEX study (Kennicutt, 1995) examined the effects of discharges at three natural gas platforms. Effects, including increased hydrocarbons, trace metals, and coarser grain size sediments, were observed within 150 m of the platforms. Localized hypoxia was observed during the summer months and attributed to stratification of the water column and increased organic material near the platform. The distribution of contaminants was patchy and there were several variables that could contribute to the observations, specifically sand from cuttings, hydrocarbons, and trace metals in the porewater. It was not possible to make a definitive judgement as to the precise source of observed toxic effects in the benthic community.

A bioaccumulation study (CSA, 1997b) examined trace metals and hydrocarbons in several fish and invertebrate species near platforms on the continental shelf. The produced-water discharge and ambient seawater were also analyzed for the same compounds. Of the 60 target chemicals, only 2 (arsenic and cadmium) were measured in the edible tissues of mollusks at levels above the USEPA risk-based concentrations. The target organic compounds were not present in most tissue samples above the target level. However, radium isotopes were measured in 55 percent of the samples, but at low concentrations.

Measurements of radium in formation water range from 40 to 1,000 picocuries/liter (pCi/l). These values are greater than marine waters, but when formation waters are discharged offshore, the radium is rapidly diluted to ambient concentrations and the higher levels are not seen as a problem (Reid, 1980).

Other Impacting Activities

Platform installation and removal results in localized sediment suspension. Also, the installation of pipelines can increase the local total suspended solids. These activities result in only a temporary adverse effect on water quality.

Supply-vessel traffic affects water quality through discharges of bilge water, ballast water, and domestic and sanitary wastes. Bilge water and sanitary wastes are treated before discharge. Ballast water is uncontaminated water but may come from a source with properties, such as lower or higher salinity, different from those of the receiving waters. Estimates of the volumes of these discharges are not available.

Summary and Conclusion

During exploration and development drilling activities, the primary impacting sources to marine water quality are discharges of drilling fluids and cuttings. Impacting discharges during production activities are produced water and supply-vessel discharges. Impacts to marine waters from a proposed action in the CPA should be minimal as long as all regulatory requirements are followed.

4.2.1.4. Impacts on Air Quality

The following activities will potentially degrade air quality: platform construction and emplacement; platform operations; drilling activities; flaring; seismic-survey and support-vessel operations; pipeline laying and burial operations; evaporation of volatile petroleum hydrocarbons during transfers and from surface oil slicks; and fugitive emissions. Supporting materials and discussions are presented in Chapters 3.1.1 (description of the coastal air quality status of the Gulf coastal area), 4.1.1.3.6 (air emissions), 4.1.1.3.9 (hydrogen sulfide), and 9.1.3 (description of the meteorology of the northern Gulf of Mexico). The parameters of this analysis are emission rates, surface winds, atmospheric stability, and the mixing height.

Emissions of certain air pollutants are known to be detrimental to public health and welfare. Some of these pollutants are directly emitted into the air, while others are formed in the atmosphere through chemical reactions. Nitric oxide and nitrogen dioxide constitute nitrogen oxide (NO_x) emissions. Nitrogen oxide, a by-product of all combustion processes, is emitted from sources such as internal combustion engines, natural gas burners, and flares. Nitrogen dioxide is a precursor pollutant involved in photochemical reactions that yield ozone. Nitrogen dioxide is an irritating gas that may increase susceptibility to infection and may constrict the airways of people with respiratory problems. Further, nitrogen dioxide can react with water to form nitric acid, which is harmful to vegetation and materials, as a result of increased acidity in precipitation (i.e., acid rain).

Carbon monoxide (CO) is a by-product of incomplete combustion, primarily contained in engine exhaust. Carbon monoxide is readily absorbed into the body through the lungs, where it reacts with hemoglobin in the blood, reducing the transfer of oxygen within the body. CO particularly affects people with cardiovascular and chronic lung diseases.

Sulfur dioxide (SO_2) may cause constriction of the airways and particularly affects individuals with respiratory diseases. Sulfur dioxide reacts in the atmosphere, principally with water vapor and oxygen, producing sulfuric acid, which along with nitric acid are the major constituents of acid rain. Acid rain can be harmful to animals, vegetation, and materials. The flaring of natural gas containing hydrogen sulfide (H_2S) and the burning of liquid hydrocarbons containing sulfur (Chapter 4.1.1.3.9) result in the formation of SO_2. The amount of SO_2 produced is directly proportional to the sulfur content of the hydrocarbons being flared or burned.

The concentration of the H_2S varies substantially from formation to formation and even varies to some degree within the same reservoir. Natural gas from the Norphlet Formation in the northeastern portion of the CPA, just south of Alabama and Mississippi, tends to range between 40 and 140 ppm on the OCS. Nevertheless, two wells are known to have H_2S concentrations of 1.8 and 2.5 percent (18,000 ppm and 25,000 ppm, respectively) in the OCS. Higher concentrations do occur within the Norphlet Formation farther north under State territorial waters and below land.

Additionally, the area around the Mississippi River Delta is a known sulfur-producing area. The natural gas in deepwater reservoirs has been mainly sweet (i.e., low in sulfur content), but the oil averages between 1 and 4 percent sulfur content by weight. By far, most of the documented production of sour gas (i.e., high sulfur content) lies within 150 km of the Breton Wilderness Area.

Flaring of sour gas is of concern because it could significantly impact onshore areas, particularly when considering the short-duration averaging periods (3 and 24 hr) for SO_2. The combustion of liquid hydrocarbon fuel is the primary source of sulfur oxides (SO_x), when considering the annual averaging period; however, impacts from high-rate well cleanup operations can generate significant SO_2 emissions. To prevent inadvertently exceeding established criteria for SO_2 for the 3-hr and 24-hr averaging periods, all incinerating events involving H_2S or liquid hydrocarbons are evaluated individually during the postlease process.

Volatile organic compounds (VOC's) are precursor pollutants involved in a complex photochemical reaction with NO_x in the atmosphere to produce ozone. The primary sources of VOC's result from venting and evaporative losses that occur during the processing and transporting of natural gas and petroleum products. A more concentrated source of VOC's is the vents on glycol dehydrator stills.

Particulate matter is comprised of finely divided solids or liquids such as dust, soot, fumes, and aerosols. The PM_{10} particles are small enough to bypass the human body's natural filtration system and can be deeply inhaled into the lungs, affecting respiratory functions. The PM_{10} can also affect visibility, primarily due to the scattering of light by the particles and, to a lesser extent, light absorption by the particles. This analysis considers mainly total suspended particulate (PM_{10}) matter.

Ozone is a nearly colorless gas with a faint but distinctive odor, somewhat similar to chlorine. It is formed in the troposphere (i.e., lower level of the atmosphere) from complex chemical reactions involving VOC's and NO_x in the presence of sunlight. At ground level, ozone can cause or aggravate respiratory problems, interfere with photosynthesis, and can damage vegetation and crack rubber. Children, the elderly, and healthy people who work or exercise strenuously outdoors are particularly sensitive to elevated ozone concentrations. In the upper atmosphere (i.e., above the troposphere), ozone is essential to life as we know it. The upper ozone layer shields the Earth's surface from harmful ultraviolet radiation. Depletion of the upper ozone layer is one of the most complex environmental issues facing the world today. This analysis will not include impacts on upper atmospheric ozone.

Emissions of air pollutants will occur during exploration, development, and production activities. The profile of typical emissions for exploratory and development drilling activities (Chapter 4.1.1.3.6) shows that emissions of NO_x are the most prevalent pollutant of concern. These emission estimates are based on a drilling scenario of a 4,115-m (13,500-ft) hole during exploration activities and a 3,050-m (10,000-ft) hole during development activities. Emissions during exploration are higher than emissions during development due to power requirements for drilling a deeper hole.

Platform emission rates for the Gulf of Mexico region (Chapter 4.1.1.3.6.) are provided from the 1992 emission inventory of OCS sources compiled by MMS (Steiner et al., 1994). This compilation was based on information from a survey of 1,857 platforms, which represented an 85 percent response rate. Since these responses included all the major oil and gas production facilities, they were deemed representative of the type of emissions to be associated with a platform. The NO_x and VOC's are the primary pollutants of concern, since both are considered to be precursors to ozone. Emission factors for other activities such as support vessels, helicopters, tankers, and loading and transit operations were obtained from Jacobs Engineering Group, Inc. (1989) and USEPA AP-42 (1985).

Flaring is the venting and/or burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation of production equipment. The MMS operating regulations provide for some limited volume, short duration flaring or venting of some natural gas volumes upon approval by MMS. These operations may occur for short periods (typically 2-14 days) as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the well bore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Emissions from flaring were included in the emissions tables and in the modeling analysis (since platform emissions included flaring along with all other sources).

Accidents, such as oil spills, blowouts and pipeline ruptures, are another source of emissions related to OCS operations. The potential impacts from these accidental events are discussed in Chapter 4.4.3.4.

Once pollutants are released into the atmosphere, atmospheric transport and dispersion processes begin circulating the emissions. Transport processes are carried out by the prevailing net wind circulation. During summer, the wind regime in the CPA is predominantly onshore at mean speeds of 3-5 m/sec (6.7-11.2 mph). Average winter winds are predominantly offshore at speeds of 4-8 m/sec (8.9-17.9 mph).

Dispersion depends on emission height, atmospheric stability, mixing height, exhaust gas temperature and velocity, and wind speed. For emissions inside the atmospheric boundary layer, the vertical heat flux, which includes effects from wind speed and atmospheric stability (via air-sea temperature differences), is a better indicator of turbulence available for dispersion (Lyons and Scott, 1990). Heat flux calculations in the CPA (USDOI, MMS, 1988) indicate an upward flux year-round, being highest during winter and lowest in summer.

The mixing height is very important because it determines the space available for spreading the pollutants. The mixing height is the height, above the surface, of the top of the layer through which vigorous vertical mixing occurs. Vertical mixing is most vigorous during unstable conditions. Vertical motion is suppressed during stable conditions; these stagnant conditions generally result in the worst periods of air quality. Although mixing height information throughout the Gulf of Mexico is scarce, measurements near Panama City (Hsu, 1979) show that the mixing height can vary between 400 and 1,300 m, with a mean of 900 m. The mixing height tends to be higher in the afternoon, more so over land than over water. Further, the mixing height tends to be lower in winter, with daily changes smaller than in summer.

Proposed Action Analysis

The emissions in tons of the criteria pollutants over the 40-year life of a proposed action are indicated in Table 4-21. The major pollutant emitted is NO_x, while PM_{10} is the least emitted pollutant. Combustion-intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly NO_x; platform operations are also the major contributors of VOC emissions. Platform construction emissions contribute appreciable amounts of all pollutants over the life of a proposed action. These emissions are temporary in nature and generally occur for a period of 3-4 months. Typical construction emissions result from the derrick barge placing the jacket and various modular components and from various service vessels supporting this operation. The drilling operations contribute considerable amounts of all pollutants. These emissions are temporary in nature and typically occur over a 40-day drilling period. Support activities for OCS activities include crew and supply boats, helicopters, and pipeline vessels; emissions from these sources consist mainly of NO_x and CO. These emissions are directly proportional to the number and type of OCS operations requiring support activities. Most emissions from these support activities occur during transit between the port and the offshore facilities; a smaller percentage of the emissions occur during idling at the platform. Platform and well emissions were calculated using the integration of projected well and platform activities over time.

Total emissions for each offshore subarea in the CPA due to a proposed action are presented in Table 4-22. Activities projected for Subarea C0-60 would generate the greatest amounts of emissions, while the other five subareas are estimated to generate lower amounts of pollutants. Pollutants are attributed to offshore subareas proportional to the projected number of production structure installations for each subarea.

The total pollutant emissions per year are not uniform. During the early years of a proposed action, emissions would be small. Emissions increase over time with platform emplacements and increasing production. After reaching a maximum, emissions would decrease as wells are depleted and abandoned, platforms are removed, and service-vessel trips and other related activities are no longer needed.

The peak-year emissions in tons per year for the criteria pollutants are indicated in Table 4-23. The peak-year emissions for a proposed action in the CPA are projected to occur in the year 2016. The peak emissions are calculated by combining peak-year activity total emissions for exploratory wells, development wells, and platforms over the life of a proposed action, and superimposing projected peak activity for support vessels and other emissions into that peak year. Peak well-drilling activities and platform emissions are not necessarily simultaneous. It is assumed for this analysis that total well and platform peak-year emissions combined with vessels and other emissions occur simultaneously. Use of the peak emissions provides the most conservative estimates of potential impacts to onshore air quality. The main pollutant emitted is NO_x, with platforms and service vessels being the primary source.

Projected peak-year activities would generate the greatest amounts of emissions in offshore Subarea C0-60 (Table 4-24). Pollutants are attributed to offshore subareas proportional to the projected number of production structure installations for each subarea.

The MMS regulations (30 CFR 250.44) do not establish annual significance levels for CO and VOC. For CO, a comparison of the projected emission rate to the MMS exemption level will be used to assess impacts. The formula to compute the emission rate in tons/yr for CO is $3{,}400 \cdot D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. The CO exempt emission level is 7,072 tons/yr at the State boundary line of 3 mi, which is greater than CO peak emissions from the whole CPA.

The VOC emissions are best addressed as their corresponding ozone impacts, which were studied in the Gulf of Mexico Air Quality Study (GMAQS). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas including the Houston/Galveston, Port Arthur/Lake Charles, and Baton Rouge areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities and the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The activities under a proposed action will not result in a doubling of the emissions, and because the proposed activities are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995). Additionally, 30 CFR 250.303(f)(2) requires that if a facility would significantly impact (defined as exceeding the MMS significance levels) an onshore nonattainment area, then it would have to reduce its impact fully through the application of the best available control technology (BACT) and possibly through offsets as well.

The implementation of the new 8-hour ozone standard, a Federal standard that is still pending court action, may affect the ozone level in coastal areas from OCS emissions. The new 8-hour ozone standard (0.08 ppm) is more stringent than the existing 1-hour standard. Thus, if the new 8-hour standard is implemented, it could result in more areas being classified as nonattainment for ozone. This may include a number of parishes in Louisiana as well as counties in Mississippi and the Florida Panhandle.

A new modeling analysis will be conducted using OCS emissions data of the year 2000. The results will be used to investigate the potential effects of OCS emissions on 8-hour average ozone levels in the near future. However, it is expected that the impact on ozone level due to contribution from OCS emissions sources would be minor, because the emission from all sources would remain about the same level or less (see also the Draft EIS on the proposed OCS Oil and Gas Leasing Program: 2002-2007; USDOI, MMS, 2001c).

It is estimated that over 99 percent of the gas and oil will be piped to shore terminals. Thus, fugitive emissions associated with tanker and barge loadings and transfer will be small, as will the associated exhaust emissions. Safeguards to ensure minimum emissions from any offloading and loading operations of OCS crude oil production from surface vessels at ports have been adopted by the State of Louisiana (Marine Vapor Recovery Act, 1989: LAC: III.2108). Current industry practice is to transport OCS-produced oil and gas via pipeline whenever feasible.

The MMS studied the impacts of offshore emissions using the Offshore and Coastal Dispersion (OCD) Model. Three large areas in the CPA were modeled. The limiting factor on the size of each area was the run time needed to process the number of sources. The areas modeled were a 150-km circle centered over Breton Island, a 100-km circle centered over the Grand Isle area, and a 150-mi circle over the Vermilion area. Receptors were set along the coastline and also a short distance inland in order to capture coastal fumigation. Circular areas were chosen to reduce edge effect. The Breton area was chosen to capture the Class I area. The other two areas were selected to best capture most of the offshore sources and to focus on the highly concentrated areas of development. Emissions for a proposed action were projected and compared to the emission inventory for the GMAQS. Ratios between these two sets of total emission rates were developed and applied to the GMAQS inventory; this modified inventory was then used as the database for the sources for the OCD modeling. Only the onshore maximum concentrations reported for all of the runs are discussed. The results of the runs are reported in the Tables 4-25 and 4-26. The results are also compared with the federally allowable increases in ambient concentrations as regulated by 30 CFR 250.45(g) and 40 CFR 51.166(c).

Tables 4-25 and 4-26 list the highest predicted contributions to onshore pollutant concentrations from OCS activities, as well as the maximum allowable increases over a baseline concentration established under the air quality regulations. While the tables show that a proposed lease sale alone would result in concentration increases that are well within the maximum allowable limits for Class I and Class II areas, a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and corresponding concentration and do not count in the determination of the maximum allowable increment. The PM_{10} are emitted at a substantially smaller rate than NO_2 and SO_2; hence, impacts from PM_{10} would be expected to be small. As a proposed action in the CPA would represent approximately 2 percent of OCS activities in the CPA, emissions from activities resulting from a proposed action would be substantially below the maximum allowable limits for a Class II area.

Suspended particulate matter is important because of its potential in degrading the visibility in national wildlife refuges or recreational parks designated as PSD Class I areas. The impact depends on emission rates and particle size. Particle size represents the equivalent diameter (diameter of a sphere) that will have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991), with two peaks located at diameters smaller than 2 µm and a third peak with diameters larger than 2 µm. Particles with diameters of 2 µm or larger settle very close to the source (residence time of approximately ½ day, Lyons and Scott, 1990). For particles smaller than 2 µm, which do not settle fast, wind transport determines their impacts. Projected PM_{10} concentrations are expected to have a low impact on the visibility of PSD Class I areas.

Gaseous and fine particulate matter in the atmosphere can potentially degrade the atmospheric visibility. The visibility degradation is primarily due to the presence of particulates with the size in the range of 1 to 2 microns. The sources of these particulates may come from fuel burning and the chemical transformation of the atmospheric constituents. The chemical transformation of NO_2, SO_2, and VOC may produce nitrates, sulfates, and carbonaceous particles. High humidity also may contribute tot he visibility impairment in the Gulf coastal areas. Visibility is considered an important resource in the Breton National Wilderness Area, a Federal Class I area. Because, future air emission from all sources in the area are expected to be about the same level or less. Thus, it is expected that the impact on visibility due to the presence of fine particulates would be minor.

The Breton National Wilderness Area is a Class I air quality area administered by U.S. Fish and Wildlife Service (FWS). Under the Clean Air Act, MMS will notify the FWS and National Park Service if emissions from proposed projects may impact the Breton Class I area. Mitigating measures, including low sulphur diesel fuels and stricter air emissions monitoring and reporting requirements, are required for sources that are located within 100 km of the Breton Class I Area and that exceed emission levels agreed upon by the administering agencies.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the activities associated with a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed-action activities are not expected to have concentrations that would change onshore air-quality classifications. The OCD modeling results show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the PSD Class I area and the PSD Class II areas.

4.2.1.5. Impacts on Marine Mammals

The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and jetsam and flotsam from service vessels and OCS structures. These major factors may affect marine mammals in the Gulf at several temporal and spatial scales that result in acute or chronic impacts.

Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; NRC, 1983; Kennicutt, 1995). Any potential impacts from drilling fluids would be indirect, either as a result of impacts to prey species or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of marine mammals or species lower in the marine food web. Marine mammals generally are inefficient assimilators of petroleum compounds in prey (Neff, 1990). Analyses of samples from stranded Gulf of Mexico bottlenose dolphins showed high levels of organochlorides and heavy metals (e.g., Salata et al., 1995; Kuehl and Haebler, 1995). Many heavy metals presumably are acquired from food, but the ultimate sources are poorly known (API, 1989). Adequate baseline data is not available to determine the significant sources of contaminants that accumulate in Gulf cetaceans or their prey, due in no small part to the fact that contaminants are introduced into the Gulf of Mexico from a suite of national and international watersheds. Many cetaceans are wide-ranging animals, which also compounds the problem. It is known that neritic cetacean species tend to have higher levels of some metals than those frequenting oceanic waters (Johnston et al., 1996). Oceanic cetaceans feeding on cephalopods have higher levels of cadmium in their tissues than comparable fish-eating species (Johnston et al., 1996). There also is, in many cases, a striking difference between the relatively high mercury levels in the toothed whales and the lower levels found in baleen whales, which is probably attributable to the different prey species consumed by baleen whales, as well as differences in the habitat (Johnston et al., 1996).

Aircraft

Aircraft overflights in proximity to cetaceans can elicit a startle response. Whales often react to aircraft overflights by hasty dives, turns, or other abrupt changes in behavior. Responsiveness varies widely depending on factors such as the activity the animals are engaged in and water depth (Richardson et al., 1995). Whales engaged in feeding or social behavior are often insensitive to overflights. Whales in confined waters, or those with calves, sometimes seem more responsive. This behavioral response could be a result of noise and/or visual disturbance. The effects appear to be transient, and there is no indication that long-term displacement of whales occur. Absence of conspicuous responses to an aircraft does not show that the animals are unaffected; it is not known whether these subtle effects are biologically significant (Richardson and Würsig, 1997).

Vessel Traffic

Of 11 species known to have been hit by vessels, fin whales are struck most frequently, sperm whales are hit commonly, and records of collisions with Bryde’s whales are rare (Laist et al., 2001). (Fin whales are rare, sperm whales are common, and Bryde’s whales are uncommon in the Gulf of Mexico.) Data compiled of 58 collisions indicate that all sizes and types of vessels can collide with whales; the majority of collisions appear to occur over or near the continental shelf; most lethal or severe injuries are caused by ships 80 m or longer; whales usually are not seen beforehand or are seen too late to be avoided; and most lethal or severe injuries involve ships traveling 14 kn or faster. Vessel collisions can significantly affect small populations of whales, such as northern right whales in the western North Atlantic (Laist et al., 2001).

Increased traffic from support vessels involved in survey, service, or shuttle functions will increase the probability of collisions between vessels and marine mammals occurring in the area. These collisions can cause major wounds on cetaceans and/or be fatal (e.g., northern right whale, Kraus, 1990, and Knowlton et al., 1997; bottlenose dolphin, Fertl, 1994; sperm whale, Waring et al., 1997). Debilitating injuries may have negative effects on a population through impairment of reproductive output. Slow-moving cetaceans (e.g., northern right whale) or those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale) might be expected to be the most vulnerable. Smaller delphinids often approach vessels that are in transit to bow-ride. It would seem that delphinids are agile enough to easily avoid being struck by vessels. However, there are occasions that dolphins are either not attentive (due to behaviors they are engaged in or perhaps because of their age/health) or there is too much vessel traffic around them, and they are struck by screws. Nowacek and Wells (2001) found that bottlenose dolphins had longer interbreath intervals during boat approaches compared to control periods (no boats present within 100 m) in a study conducted in Sarasota Bay, Florida. They also found that dolphins decreased interanimal distance, changed heading, and increased swimming speed significantly more often in response to an approaching vessel than during control periods.

Toothed whales (and baleen whales, to a lesser extent) show some tolerance of vessels, but may react at distances of several kilometers or more when confined by environmental features or when they learn to associate the vessel with harassment. Evidence suggests that certain whales have reduced their use of certain areas heavily utilized by ships (Richardson et al., 1995), possibly avoiding or abandoning important feeding areas, breeding areas, resting areas, or migratory routes. The continued presence of various cetacean species in areas with heavy boat traffic indicates a considerable degree of tolerance to ship noise and disturbance. An experiment involving playback of low-frequency sound in the Canary Islands suggests that sperm whales from an area that has heavy vessel traffic have a high tolerance for noise (Andre et al., 1997). There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or growth, unless they occur frequently.

Long-term displacement of animals, in particular baleen whales, from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance are stressed or otherwise affected in a negative, but inconspicuous way (Richardson et al., 1995). Stress or "alert" responses could occur quite early during an encounter. For example, Myrick and Perkins (1995) found stress responses occurring as early as the chase stage in purse-seine netting on dolphins.

It is possible that manatees could occur in coastal areas where vessels traveling to and from the leased sites could affect them. If a manatee should be present where there is vessel traffic, they could be injured or killed by a boat striking them (Wright et al., 1995). Inadequate hearing sensitivity at low frequencies may be a contributing factor to the manatees' inability to effectively detect boat noise and avoid collisions with boats (Gerstein et al., 1999).

Drilling and Production Noise

Exploration, delineation, and production structures, as well as drillships, produce an acoustically wide range of sounds at frequencies and intensities that can be detected by cetaceans. Some of these sounds could mask cetaceans' reception of sounds produced for echolocation and communication. Odontocetes use sounds at frequencies that are generally higher than the dominant sounds generated by offshore drilling and production activities. Low-frequency hearing has not been studied in many species, but bottlenose dolphins can hear sounds at frequencies as low as 40-125 Hz. Below 1 kHz, where most OCS-industry noise energy is concentrated, sensitivity seems poor (Richardson et al., 1995). Pilot whales and sperm whales changed their behavior (in particular, ceased vocalizations) during low-frequency transmissions from the Heard Island Feasibility Test in the southern Indian Ocean (Bowles et al., 1994); this throws doubt on the assumed insensitivity of odontocete hearing at low frequencies. Baleen whales mainly utter low-frequency sounds that overlap broadly with the dominant frequencies of many OCS-industry sounds. There are indirect indications that baleen whales are sensitive to low- and moderate-frequency sounds (Richardson et al., 1995). Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies, averaging 5 Hz and 10-500 Hz, respectively (Richardson et al., 1995). There is particular concern for baleen whales that are apparently more dependent on low-frequency sounds than are other marine mammals; many industrial sounds are concentrated at low frequencies. Drillships produce higher levels of underwater noise than other types of platforms. There are few published data on underwater noise levels near production platforms and on the marine mammals near those facilities (Richardson et al., 1995). However, underwater strong noise levels may often be low, steady, and not very disturbing (Richardson et al., 1995). Stronger reactions would be expected when sound levels are elevated by support vessels or other noisy activities (Richardson et al., 1995).

Human-made sounds may affect the ability of marine mammals to communicate and to receive information about their environment (Richardson et al., 1995). Such noise may interfere with or mask the sounds used and produced by these animals and thereby interfere with their natural behavior. These sounds may frighten, annoy, or distract marine mammals and lead to physiological and behavioral disturbances. The response threshold may depend on whether habituation (gradual waning of behavioral responsiveness) or sensitization (increased behavioral responsiveness) occurs (Richardson et al., 1995). Sounds can cause reactions that might include disruption of marine mammals' normal activities (behavioral and/or social disruption) and, in some cases, short- or long-term displacement from areas important for feeding and reproduction (Richardson et al., 1995). The energetic consequences of one or more disturbance-induced periods of interrupted feeding or rapid swimming, or both, have not been evaluated quantitatively. Energetic consequences would depend on whether suitable food is readily available. Of the animals responding to noise, females in late pregnancy or lactating would probably be most affected. Human-made noise may cause temporary or permanent hearing impairment in marine mammals if the noise is strong enough. Such impairment would have the potential to diminish the individual's chance for survival. Tolerance of noise is often demonstrated, but this does not prove that the animals are unaffected by noise; for example, they may become stressed, making the animal(s) more vulnerable to parasites, disease, environmental contaminants, and/or predation. Noise-induced stress is possible, but little studied in marine mammals. Aversive levels of noise might cause animals to become irritable, affecting feed intake, social interactions, or parenting; all of these effects might eventually result in population declines (Bowles, 1995).

Structure Removals

A limited amount of information is available on the effects of explosions on marine mammals (O'Keeffe and Young, 1984; Ketten, 1998). The shock wave produced by explosions can cause physical damage to nearby animals. The potential for injury is associated with gas-containing internal organs, such as the lungs and intestines (Yelverton et al., 1973). Data are limited regarding blast-induced auditory damage. Explosions and shock waves and their intense transient sound field have the ability to produce blast injury and acoustic trauma in marine mammals (Ketten, 1995 and 1998). Consequences of hearing damage may range from subtle modification of certain behaviors that require a modicum of hearing ability to acute, where concussive effects may lead to death (Ketten, 1995).

For example, two humpback whales were found with damage to their ear bones following an explosion in Newfoundland (Ketten et al., 1993). Yet other humpback whales in Newfoundland, foraging in an area of explosive activity, showed little behavioral reaction to the detonations in terms of decreased residency, overall movements, or general behavior, though orientation ability appeared to be affected (Todd et al., 1996). Todd et al. (1996) suggested caution in interpretation of the lack of visible reactions as indication that whales are not affected or harmed by an intense acoustic stimulus; both long- and short-term behavior as well as anatomical evidence should be examined. The researchers interpreted increased entrapment rate of humpback whales in nets as the whales being influenced by the long-term effects of exposure to deleterious levels of sound.

Odontocetes cannot hear well in the frequencies emitted by explosive detonations (Richardson et al., 1995). The animals may not be able to hear the pulse generated from open-water detonations of explosive charges because it is very brief (*Federal Register*, 1995a). Sublethal effects would include a startle response. Even if dolphins are not capable of hearing the acoustic signature of the explosion, physiological, pathological, or behavioral responses to detonations may still result. The NMFS (USDOC, NMFS, 1995) cites such examples as detection of low-frequency sound by some mechanism other than conventional hearing and harassment due to tactile stings from the shock wave accompanying detonations. Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995a). Because of its temporary effect, no impacts to higher life forms are expected, and, because of its temporary and localized nature, biomagnification is unlikely.

The extent of potential injury is dependent upon the amount of explosive used, distance from the charge, and body mass of the cetacean. As explained in detail in the USDOC, NMFS (1995), it may be assumed that marine mammals more than 3,000 ft (910 m) from structures to be removed would avoid injury caused by explosions. There is no evidence linking dolphin injuries or deaths in the Gulf to explosive removal of structures (Klima et al., 1988; Gitschlag et al., 1997). In October 1995, NMFS issued regulations authorizing and governing the taking of bottlenose and spotted dolphins incidental to the removal of gas drilling and production structures in State waters and on the Gulf of Mexico OCS for a period of five years (*Federal Register*, 1995a). Those regulations are currently being reviewed and revised by MMS and NOAA Fisheries.

In order to minimize the likelihood of removals occurring when cetaceans may be nearby, MMS has issued guidelines (NTL 2001-G08) for removing offshore structures with explosives to offshore operators. These guidelines specify explosive removals only during daylight hours, staggered detonation of explosive charges, placement of charges 5 m below the seafloor, and pre- and post-detonation aerial surveys within one hour before and after detonation. Trained observers watch for sea turtles and marine mammals in the vicinity of the structures to be removed.

Seismic Surveys

The MMS has almost completed a programmatic EA on G&G permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference. Seismic surveys use a high-energy noise source. During Irish Sea seismic surveys, pulses were audible on hydrophone recordings above the highly elevated background ship noise at least up to the 20-km range (Goold and Fish, 1998). Although the output of airgun arrays is usually tuned to concentrate low-frequency energy, a broad frequency spectrum is produced, with significant energy at higher frequencies (e.g., Goold and Fish, 1998). These energies encompass the entire audio frequency range of 20 Hz to 20 kHz (Goold and Fish, 1998) and extend well into the ultrasonic range up to 50 kHz.

Baleen whales seem quite tolerant of low- and moderate-level sound pulses from distant seismic surveys but exhibit behavioral changes in the presence of nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing, respiration, and dive cycles have been noted (Richardson et al., 1995; Richardson, 1997). Response appears to diminish gradually with increasing distance and decreasing sound level (Richardson, 1997). Bowhead and gray whales often show strong avoidance within 6-8 km of an airgun array. Humpback whales off western Australia were found to change course at 3-6 km from an operating seismic survey vessel, with most animals keeping a standoff range of 3-4 km (McCauley et al., 1998a and b). Humpback whale groups containing females involved in resting behavior in key habitat types were more sensitive than migrating animals and showed an avoidance response estimated at 7-12 km from a large seismic source (McCauley et al., 2000). Whales exposed to sound from distant seismic survey ships may be affected even though they remain in the area and continue their normal activities (Richardson et al., 1995). For baleen whales, in particular, it is not known (1) whether the same individuals return to areas of previous seismic exposure, (2) whether seismic work has caused local changes in distribution or migration routes, or (3) whether whales that tolerate strong seismic pulses are stressed (Richardson et al., 1995). Individually identified gray whales remained in Puget Sound long after the seismic survey (as is normal), despite being exposed to noise (Calambokidis and Osmek, 1998; Bain et al., 1999).

Goold (1996) found that acoustic contacts with common dolphins in the Irish Sea dropped sharply as soon as seismic activity began, suggesting a localized disturbance of dolphins. It was also estimated that seismic energy from the 2,120-in^3 airgun array in a shelf sea environment was safe to common dolphins at a radius from the gun array of 1 km (Goold and Fish, 1998). Given the high, broadband seismic-pulse power levels across the entire recorded bandwidth and the known auditory thresholds for several dolphin species, Goold and Fish (1998) considered such seismic emissions to be clearly audible to dolphins across a bandwidth of tens of kilohertz and at least out to the 8-km range.

Sperm whales during the Heard Island Feasibility Test were found to cease calling during some (but not all) times when seismic pulses were received from an airgun array more than 300 km away (Bowles et al., 1994) (whether sperm whales were responding directly to the seismic pulses is not known). In contrast, there are observations of sperm whales in the Gulf continuing to vocalize while seismic pulses are ongoing (Evans, personal communication, 1999). One report of Gulf of Mexico sperm whales suggested that the animals may have moved 50+ km away in response to seismic pulses (Mate et al., 1994), but further work suggests that the animals may not have moved in response to the sound, but perhaps relative to oceanographic features and prey distribution. It is unclear whether the well-documented, continued occurrence of sperm whales in the area off the mouth of the Mississippi River is a consequence of low sensitivity to seismic sound or a high motivation to remain in the area. Sperm whales have historically occupied this area; their continued presence might suggest habituation to the seismic signals. During the MMS-sponsored GulfCet II study on marine mammals, results showed that the cetacean sighting rate did not change significantly due to seismic exploration signals (Davis et al., 2000). The analysis of the results was unable to detect small-scale (<100 km) changes in cetacean distribution. Results of passive acoustic surveys to monitor sperm whale vocal behavior and distribution in relation to seismic surveys in the northeast Atlantic revealed few, if any, effects of airgun noise (Swift et al., 1999). The authors suggested that sperm whales in that area may be habituated to seismic surveys and/or responses may occur at scales to which the research was not sensitive.

No obvious behavior modifications relative to the seismic activity were recorded during the majority of the small odontocete observations made during marine mammal monitoring carried out during a 3D seismic survey offshore California in late 1995 (Arnold, 1996). There was also no observable behavior modification or harassment of large whales attributable to the sound effects of the survey (Arnold, 1996).

There are no data on auditory damage in marine mammals relative to received levels of underwater sound pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals given a study of damage risk criteria; the transitory nature of seismic exploration; the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals; and the avoidance responses that occur in at least some baleen whales, when exposed to certain levels of seismic pulses (Richardson et al., 1995).

Flotsam and Jetsam

In recent years, there has been increasing concern about manmade debris (discarded from offshore and coastal sources) and its impact on the marine environment (e.g., Shomura and Godfrey, 1990; Laist, 1997). Both entanglement in and ingestion of debris has caused the death or serious injury of marine mammals (Heneman and the Center for Environmental Education, 1988; MMC, 1998). The debris items most often found entangling animals are net fragments and monofilament line from commercial and recreational fishing boats, as well as strapping bands and ropes probably from all types of vessels. Plastic bags and small plastic fragments are the most commonly reported debris items in the digestive tracts of cetaceans and manatees (e.g., Barros and Odell, 1990; Tarpley and Marwitz, 1993; Laist, 1997; MMC, 1998). Many types of plastic materials are used during drilling and production activities; the offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). The MMS prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by lessees (30 CFR 250.40). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste items into both offshore and coastal waters was established January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which the USCG enforces. Accidental release of debris from OCS activities is known to occur offshore, and such flotsam may injure or kill cetaceans.

Proposed Action Analysis

The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and jetsam and flotsam from service vessels and OCS structures.

Information on drilling fluids, drill cuttings, and produced waters that would be discharged offshore as a result of a proposed action is provided in Chapter 4.1.1.3.4. Some effluents are routinely discharged into offshore marine waters. It is expected that cetaceans may have some interaction with these discharges. Direct effects to cetaceans are expected to be sublethal. It should be noted, however, that any pollution in the effluent could poison and kill or debilitate marine mammals and adversely affect the food chains and other key elements of the Gulf ecosystem (Tucker & Associates, Inc., 1990). Because OCS discharges are diluted and dispersed in the offshore environment, impacts to cetaceans are expected to be negligible.

Helicopter activity projections are 220,000-870,000 trips over the life of a proposed action (Table 4-2) or 5,641-22,308 trips annually. The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum altitudes (noted below) over noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. In addition, guidelines and regulations promulgated by NOAA Fisheries under the authority of the Marine Mammal Protection Act do include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 100 yd (91 m) of marine mammals. It is unlikely that cetaceans would be affected by routine OCS helicopter traffic operating at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. It is expected that about 10 percent of helicopter trips would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from, and interrupt cetaceans nearby (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences if they repeatedly disrupt vital functions, such as feeding and breeding. Frequent overflights are expected in coastal and Federal neritic waters. Generally, overflights become less frequent as the distance from shore of the OCS facilities being serviced increases; however, many offshore fields are supported by resident helicopters, resulting in increased localized overflights. The area supported by a resident helicopter is dependent in part on the size of the field that it supports. Temporary disturbance to cetaceans may occur on occasion as helicopters approach or depart OCS facilities, if animals are near the facility. Such disturbance is believed negligible.

An estimated 63,000-111,000 OCS-related, service-vessel trips are expected to occur over the life of a proposed action (Table 4-2). The rate of trips would be about 1,615-2,846 trips/yr. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from cetaceans or mask their sound reception. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity. Long-term displacement of animals from an area is also a consideration. It is not known whether toothed whales exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased ship traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals. Smaller delphinids may approach vessels that are in transit to bow-ride. Limited observations on an NMFS cruise off the mouth of the Mississippi River in the summer of 2000 indicated that sperm whales appeared to avoid passing service vessels. However, marine mammalogists conducting surveys in the CPA during the summer of 2001 documented an adult killer whale that bore conspicuous and aged scarring across its back that were indubitably the result of a collision with a motor vessel. A manatee was unintentionally hit and killed by a boat off Louisiana (Schiro et al., 1998). Another manatee was killed by vessel traffic (type of vessel unknown) in Corpus Christi Bay in October 2001 (Beaver, personal communication, 2001). It appears there is limited threat posed to smaller, coastal delphinids where the majority of OCS vessel traffic occurs; however, as exploration and development of petroleum resources in oceanic waters of the northern Gulf increases, OCS vessel activity will increase in these waters, thereby increasing the risk of vessel strike to sperm whales and other deep-diving cetaceans (e.g., *Kogia* and beaked whales). Deep-diving whales are more vulnerable to vessel strikes because of the extended surface period required to recover from extended deep dives. Manatees are rare in the western and central Gulf, consequently, there is little risk posed by OCS vessel traffic.

A total of 111-247 exploration wells and 178-352 development wells are projected to be drilled as a result of a proposed action (Table 4-2). A total of 28-49 production structures are projected to be installed as a result of a proposed action (Table 4-2). These wells and platforms could produce sounds at intensities and frequencies that could be heard by cetaceans. It is expected that noise from drilling activities would be relatively constant and last no longer than four months per well. Odontocetes echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms. Sound levels in this range are not expected to be generated by drilling operations (Gales, 1982). Bottlenose dolphins, one of the few species in which low-frequency sound detection has been studied, have been found to have poor sensitivity levels at the level where most industrial noise energy is concentrated. There is some concern for baleen whales since they are apparently more dependent on low-frequency sounds than other marine mammals; however, except for the Bryde's whale, baleen whales are extralimital or accidental in occurrence in the Gulf. During GulfCet surveys, Bryde's whale was sighted only in the EPA; these sightings were in waters deeper than 100 m (Davis et al., 2000). Therefore, Bryde's whale would not likely be subjected to OCS drilling and production noise. Potential effects on Gulf of Mexico marine mammals include disturbance (subtle changes in behavior, interruption of previous activities, or short- or long-term displacement); masking of calls from conspecifics, reverberations from own calls, and other natural sounds (e.g., surf, predators); stress (physiological); and hearing impairment (permanent or temporary) by explosions and strong nonexplosive sounds.

Potential impacts to marine mammals from the detonation of explosives include lethal and injurious incidental take, as well as physical or acoustic harassment. Injury to the lungs and intestines and/or auditory system could occur. Harassment of marine mammals as a result of a noninjurious physiological response to the explosion-generated shock wave as well as to the acoustic signature of the detonation is also possible. It is estimated that 16-29 production structures resulting from a proposed action would be removed using explosives (Table 4-2). It is expected that structure removals would cause only minor behavioral changes and noninjurious physiological effects on cetaceans as a result of the implementation of MMS guidelines and NOAA Fisheries Observer Program for explosive removals (Chapter 4.1.1.3.3).

To date, there are no documented "takes" of marine mammals resulting from explosive removals of offshore structures.

Many types of materials, including plastics, are used during drilling and production operations. Some of this material is accidentally lost overboard where cetaceans can consume it. The result of ingesting some materials lost overboard could be lethal. The relationship between the occurrence of these waste products and the quantities ingested that produce a lethal effect are unknown.

Summary and Conclusion

Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible debris, particularly plastic items, lost from service vessels, drilling rigs, and fixed and floating platforms. Deaths due to structure removals are not expected due to existing mitigation measures or those being developed for structures placed in oceanic waters. There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification, although the scope of effects and their magnitude are not known.

The routine activities of a proposed action is not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population stock endemic to the northern Gulf of Mexico.

4.2.1.6. Impacts on Sea Turtles

The major impact-producing factors resulting from the routine activities associated with a proposed action that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles include water-quality degradation from operational discharges; noise from helicopter and vessel traffic, operating platforms, and drillships; vessel collisions; brightly-lit platforms; explosive platform removals; and OCS-related trash and debris.

Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by USEPA NPDES permits. Most operational discharges, as regulated, are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would seem to be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web (for further information on bioaccumulation, see Chapter 4.1.1.3.4). Sea turtles may bioaccumulate chemicals such as heavy metals that occur in drilling mud. This might ultimately reduce reproductive fitness in the turtles, an impact that the already diminished population(s) cannot tolerate. Samples from stranded turtles in the Gulf of Mexico carry high levels of organochlorides and heavy metals (Sis et al., 1993).

Noise

There are no systematic studies published of the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. However, it is assumed that aircraft noise could be heard by a sea turtle at or near the surface and cause the animal to alter its normal behavior pattern (Advanced Research Projects Agency, 1995). Noise from service-vessel traffic may elicit a startle reaction from sea turtles and produce a temporary sublethal stress (NRC, 1990). Startle reactions may result in increased surfacings, possibly causing an increase in risk of vessel collision. Reactions to aircraft or vessels, such as avoidance behavior, may disrupt normal activities, including feeding. Important habitat areas (e.g., feeding, mating, and nesting) may be avoided due to noise generated in the vicinity. There is no information regarding the consequences that these disturbances may have on sea turtles in the long term. If sound affects any prey species, impacts to sea turtles would depend on the extent that prey availability might be altered.

Drilling and production facilities produce an acoustically wide range of sounds at frequencies and intensities that could possibly be detected by turtles. Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies (Richardson et al., 1995). Sea turtle hearing sensitivity is not well studied. A few preliminary investigations using adult green, loggerhead, and Kemp's ridley turtles suggest that they are most sensitive to low-frequency sounds (Ridgway et al., 1969; Lenhardt et al., 1983; Moein Bartol et al., 1999). It has been suggested that sea turtles use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al., 1983). Bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving structures (Lenhardt et al., 1983).

Noise-induced stress has not been studied in sea turtles. Captive loggerhead and Kemp's ridley turtles exposed to brief, audio-frequency vibrations initially showed startle responses of slight head retraction and limb extension (Lenhardt et al., 1983). Sound-induced swimming has been observed for captive loggerheads and greens (O'Hara and Wilcox, 1990; Moein Bartol et al., 1993; Lenhardt, 1994). Some loggerheads exposed to low-frequency sounds responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt, 1994). Sea turtles have been seen to begin to noticeably increase their swimming in response to an operating seismic source at 166 dB re-1µPa-m (measurement of sound level in water) (McCauley et al., 2000). The MMS haas almost completed a programmatic EA on G&G permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference. An anecdotal observation of a free-ranging leatherback's response to the sound of a boat motor suggests that leatherbacks may be sensitive to low-frequency sounds, but the response could have been to mid- or high-frequency components of the sound (Advanced Research Projects Agency, 1995). The potential direct and indirect impacts of sound on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Low-frequency sound transmissions could potentially cause increased surfacing and avoidance from the area near the sound source (Lenhardt et al., 1983; O'Hara and Wilcox, 1990; McCauley et al., 2000). The potential for increased surfacing could place turtles at greater risk of vessel collisions and potentially greater vulnerability to natural predators.

Vessel Collisions

Data show that vessel traffic is one cause of sea turtle mortality in the Gulf (Lutcavage et al., 1997). Stranding data for the U.S. Gulf of Mexico and Atlantic coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993 about 9 percent of living and dead stranded sea turtles had boat strike injuries (n=16, 102) (Lutcavage et al., 1997). However, vessel-related injuries were noted in 13 percent of stranded turtles examined from strandings in the Gulf of Mexico and on the Atlantic Coast during 1993 (Teas, 1994), but this figure includes those that may have been struck by boats post-mortem. In Florida, where coastal boating is popular, 18 percent of strandings documented between 1991 and 1993 were attributed to vessel collisions (Lutcavage et al., 1997). Large numbers of loggerheads and 5-50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (NRC, 1990; Lutcavage et al., 1997). Numbers of OCS-related vessel collisions with sea turtles offshore are unknown, but it is expected that some sea turtles will be impacted.

Brightly-lit Platforms

Brightly-lit, offshore drilling facilities present a potential danger to hatchlings (Owens, 1983). Hatchlings are known to be attracted to light (Raymond, 1984; Witherington and Martin, 1996; Witherington, 1997) and may orient toward lighted offshore structures (Chan and Liew, 1988). If this occurs, hatchling predation might increase dramatically since large birds and predatory fishes also congregate around structures (Owens, 1983; Witherington and Martin, 1996).

Structure Removals

Offshore structures serve as artificial reefs and are sometimes used by sea turtles (Gitschlag and Herczeg, 1994). The dominant species of turtle observed at explosive structure removals is the loggerhead, but leatherback, green, Kemp's ridley, and hawksbill have also been observed (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). Loggerheads may reside at specific offshore structures for extended periods of time (Rosman et al., 1987b; Gitschlag and Renaud, 1989). The probability of occupation by sea turtles increases with the age of the structures (Rosman et al., 1987b). Sea turtles probably use platforms as places to feed and rest. Offshore structures afford refuge from predators and stability in water currents, and loggerheads have been observed sleeping under platforms or beside support structures (Hastings et al., 1976; Rosman et al., 1987b; Gitschlag and Renaud, 1989). Only near the Chandeleur and Breton Islands were sea turtles positively associated with platforms (Lohoefener et al., 1989 and 1990).

Information about the effects of underwater explosions on sea turtles is limited. O'Keeffe and Young (1984) assumed that shock waves would injure the lungs and other organs containing gas, expected that ear drums of turtles would be sensitive, and suggested that smaller turtles would suffer greater injuries from the shock wave than larger turtles. The NMFS conducted several studies before and after an explosive platform removal to determine its effects on sea turtles in the immediate vicinity (Duronslet et al., 1986; Klima et al., 1988). Immediately after the explosion, turtles within 3,000 ft of the platform were rendered unconscious (Klima et al., 1988), although they resumed apparently normal activity 5-15 minutes post-explosion (Duronslet et al., 1986). One of these turtles also sustained damage to the cloacal lining (it was everted) (Klima et al., 1988). Dilation of epidermal capillaries was a condition that continued for three weeks, after which time all turtles appeared normal. Effects on their hearing were not determined. Impacts of explosive removals on sea turtles are not easily assessed, primarily because turtle behavior makes observations difficult. Sea turtles in temperate latitudes generally spend less than 10 percent of their time at the surface, and dive durations can exceed one hour. Injured turtles that are capable of swimming may return to the surface, while moribund turtles may sink to the seafloor or drift away from the work site. Unconsciousness renders a turtle more susceptible to predation; effects of submergence on stunned turtles is unknown (Klima et al., 1988). The number of documented sea turtles impacted by explosives is two loggerheads during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996), one loggerhead in 1997 (Gitschlag, personal communication, 1999), one loggerhead in 1998 (Shah, personal communication, 1998), and one loggerhead in 2001 (Gitschlag, personal communication, 2001). A total of six additional sea turtles have been captured prior to detonation of explosives and saved from possible injury or death (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). The low number of turtles affected by explosive removal of structures may be due to the few turtles that occur in harm's way at the time explosives are detonated, the effectiveness of the monitoring program established to protect sea turtles, and/or the inability to adequately assess and detect impacted animals.

In 1987, in response to 51 dead sea turtles that washed ashore on Texas beaches (explosions were identified as the primary cause by Klima et al., 1988), NMFS initiated an observer program at explosive removals of structures in State and Federal waters of the Gulf of Mexico. For at least 48 hours prior to detonation, NOAA Fisheries observers watch for sea turtles at the surface. Helicopter surveys within a 1-mi radius of the removal site are conducted a minimum of 30 minutes prior to and after detonation (Gitschlag and Herczeg, 1994). If sea turtles are observed, detonations are delayed until the turtles have been safely removed or have left the area. Monitoring the water's surface for sea turtles is not 100 percent effective. Once observed, there is currently no practical and efficient means of removing a sea turtle from the area that will be impacted by explosives (Gitschlag and Herczeg, 1994). Although divers have had some success in capturing sea turtles, this procedure is limited to animals resting or sleeping beneath structures.

Even if turtles are not capable of hearing the acoustic properties of an explosion, physiological or behavioral responses (startle) to detonations may still result (USDOC, NMFS, 1995). Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995a). Because of its temporary effect and localized nature, biomagnification is unlikely.

Jetsam and Flotsam

A wide variety of trash and debris is commonly observed in the Gulf. Marine trash and debris comes from a variety of land-based and ocean sources (Cottingham, 1988). Some material is accidentally lost during drilling and production operations. From March 1, 1994, to February 28, 1995, a total of 40,580 debris items were collected in a 16-mi transect made along the Padre Island National Seashore (Miller et al., 1995). The offshore oil and gas industry was shown to contribute 13 percent of the trash and debris found in the transect. Turtles may become entangled in drifting debris and ingest fragments of synthetic materials (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988). Entanglement usually involves fishing line or netting (Balazs, 1985). Once entangled, turtles may drown, incur impairment to forage or avoid predators, sustain wounds and infections from the abrasive or cutting action of attached debris, or exhibit altered behavior that threaten their survival (Laist, 1987). Both entanglement and ingestion have caused the death or serious injury of individual sea turtles (Balazs, 1985). Balazs (1985) compiled dozens of records of sea turtle entanglement, ingestion, and impaction of the alimentary canal by ingested plastics, although tar was the most common item ingested. The marked tendency of leatherbacks to ingest plastic has been attributed to misidentification of the translucent films as jellyfish. Lutz (1990) concluded that turtles will actively seek out and consume plastic sheeting. Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby lessening the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist, 1987). Weakened animals are then more susceptible to predators and disease; they are also less fit to migrate, breed, or nest successfully.

The initial life history of sea turtles involves the hatching of eggs, evacuation of nests, and commencement of an open-ocean voyage. Some hatchlings spend their "lost years" in sargassum rafts; ocean currents concentrate or trap floating debris in sargassum (Carr, 1987). Witherington (1994) studied post-hatchling loggerheads in drift lines 8-35 nmi east of Cape Canaveral and Sebastian Inlet, Florida. Out of 103 turtles captured, 17 percent of the animals contained plastic or other synthetic fibers in their stomachs or mouths. The Gulf of Mexico had the second highest number of turtle strandings affected by debris (35.9%) (Witzell and Teas, 1994). Although the Kemp's ridley is the second most commonly stranded turtle, they are apparently less susceptible to the adverse impacts of debris than the other turtle species for some unknown reason (Witzell and Teas, 1994). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters.

Proposed Action Analysis

Information on drilling fluids, drill cuttings, and produced waters that would be discharged offshore as a result of a proposed action is provided in Chapter 4.1.1.3.4. These effluents are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Turtles may be affected by these discharges. Very little information exists on the impact of drilling muds on Gulf sea turtles (Tucker and Associates, Inc., 1990).

Structure installation, pipeline placement, dredging, blowouts, and water quality degradation can impact seagrass bed and live-bottom sea turtle habitats. These impacts are analyzed in detail in Chapter 4.2.1.1. A discussion of the causes and magnitude of wetland loss as a result of a proposed action can be found in Chapter 4.2.1.1.2. The seagrass and high-salinity marsh components of wetland loss would be indirectly important for sea turtles by reducing the availability of forage species that rely on these sensitive habitats. Little or no damage is expected to the physical integrity, species diversity, or biological productivity of live-bottom marine turtle habitat as a result of a proposed action because these sensitive resources are protected by several mitigation measures established by MMS.

An estimated 63,000-111,000 OCS-related, service-vessel trips are expected to occur over the life of a proposed action (Table 4-2). The rate of trips would be about 1,615-2,846 trips/yr. Transportation corridors would be through areas where sea turtles have been sighted. Helicopter activity projections are 220,000-870,000 trips over the life of a proposed action (Table 4-2) or 5,641-22,308 trips annually. Noise from service-vessel traffic and helicopter overflights may elicit a startle reaction from sea turtles; there is the possibility of short-term disruption of activity patterns. Sounds from approaching aircraft are detected in the air far longer than in water. For example, an approaching Bell 214ST helicopter became audible in the air more than four minutes before passing overhead, while it was detected underwater for only 38 seconds at 3-m depth and for 11 seconds at 18-m depth (Greene, 1985 *in* Richardson et al., 1995). There are no systematic studies published concerning the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. It is assumed that aircraft noise could be heard by a sea turtle at or near the surface and cause it to alter its activity (Advanced Research Projects Agency, 1995). In the wild, most sea turtles spend at least 3-6 percent of their time at the surface. Despite the brevity of their respiratory phases, sea turtles sometimes spend as much as 19-26 percent of their time at the surface, engaged in surface basking, feeding, orientation, and mating (Lutcavage et al., 1997). Sea turtles located in shallower waters have shorter surface intervals, whereas turtles occurring in deeper waters have longer surface intervals. It is not known whether turtles exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased vessel traffic will increase the probability of collisions between vessels and turtles, potentially resulting in injury or death to some animals.

A total of 111-247 exploratory wells and 178-352 development wells are projected to be drilled as a result of a proposed action (Table 4-2). A total of 28-49 production structures are projected as a result of a proposed action (Table 4-2). These structures could generate sounds at intensities and frequencies that could be heard by turtles. There is some evidence suggesting that turtles may be receptive to low-frequency sounds, which is at the level where most industrial noise energy is concentrated. Potential effects on turtles include disturbance (subtle changes in behavior, interruption of activity), masking of other sounds (e.g., surf, predators, vessels), and stress (physiological).

It is estimated that 16-29 production structures would be removed by explosives as a result of a proposed action (Table 4-2). Potential impacts to sea turtles from the detonation of explosives include death, injury, stress, and physical or acoustic harassment. Injury to the lungs and intestines, and/or auditory system could occur. It is expected that structure removals would cause chiefly sublethal effects on sea turtles as a result of MMS guidelines for explosive removals (Chapter 4.1.1.4.2). Since 1986 when explosive removals were identified as a potential source of "take" of sea turtles, there have been only five documented "takes" of loggerhead sea turtles attributed to explosive removals.

Sea turtles can become entangled in or ingest debris produced by exploration and production activities resulting from a proposed action. Leatherback turtles that mistake plastics for jellyfish may be more vulnerable to gastrointestinal blockage than other sea turtle species. The probability of plastic ingestion/entanglement is unknown.

Summary and Conclusion

Routine activities resulting from a proposed action have the potential to harm individual sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by helicopter and vessel traffic, platforms, and drillships; brightly-lit platforms; explosive removals of offshore structures; vessel collisions; and jetsam and flotsam generated by service vessels and OCS facilities. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials. "Takes" due to explosive removals are expected to be rare due to mitigation measures already established (e.g., NMFS Observer Program) and in development. Most OCS activities are expected to have sublethal effects. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effects. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or fecundity, and result in either population declines, however, such declines are not expected. The routine activities of a proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the Gulf of Mexico.

4.2.1.7. Impacts on Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

The Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice are designated as protected species under the Endangered Species Act of 1973 (Chapter 1.3). The mice occupy restricted habitat behind coastal foredunes of Florida and Alabama (Ehrhart, 1978; USDOI, FWS, 1987). Portions of the beach mouse habitat have been designated as critical.

Proposed Action Analysis

The major impact-producing factors associated with a proposed action in the CPA that may affect beach mice include beach trash and debris, efforts undertaken for the removal of marine debris or for beach restoration, offshore and coastal oil spills, and spill-response activities. The potential impacts from spills and spill-response activities are discussed in Chapter 4.4.3.7.

Trash and debris may be mistakenly consumed by beach mice. Mice may become entangled in the debris. A proposed action in the CPA is expected to contribute negligible marine debris or disruption to beach mice areas. Efforts undertaken for the removal of marine debris or for beach restoration, such as sand replenishment, may temporarily scare away beach mice, destroy their food resources such as sea oats, or collapse the tops of their burrows.

Summary and Conclusion

An impact from a proposed action in the CPA on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice is possible but unlikely. Impact may result from consumption of beach trash and debris by beach mice, and efforts to clean up trash and debris.

4.2.1.8. Impacts on Coastal and Marine Birds

This section discusses the possible effects of a proposed action in the CPA on coastal and marine birds of the Gulf of Mexico and its contiguous waters and wetlands. Major, potential impact-producing factors for marine birds in the offshore environment include OCS-related helicopter and service-vessel traffic and noise, air emissions, degradation of water quality, habitat degradation, and discarded trash and debris from service-vessels and OCS structures. Any effects are especially grave for intensively managed populations. For example, endangered and threatened species may be harmed by any impact on viable reproductive population size or disturbance of a few key habitat factors.

Proposed Action Analysis

Noise

The transportation or exchange of supplies, materials, and personnel between coastal infrastructure and offshore oil and gas structures is accomplished with helicopters, aircraft, and boats and a variety of service vessels. It is projected that 220,000-870,000 helicopter flights related to a proposed action in the CPA would occur over the life of a proposed action; this is a rate of 5,500-21,750 annual helicopter trips. Service vessels would use selected nearshore and coastal (inland) navigation waterways, or corridors, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. It is projected that 63,000-111,000 service-vessel trips related to a proposed action in the CPA would occur in the life of a proposed action; this is a rate of 1,575-2,775 service-vessels trips annually.

Major concerns related to helicopter and service-vessel traffic are intense aversion, panic, and head injury following a bird's collision with helicopters or vessels. Disturbances from OCS-related helicopter or service-vessel traffic to coastal birds can result from the mechanical noise or physical presence (or wake) of the vehicle. The degree of disturbance exhibited by groups of coastal birds to the presence of air or vessel traffic is highly variable, depending upon the bird species in question, type of vehicle, altitude or distance of the vehicle, the frequency of occurrence of the disturbance, and the season. Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior. Disturbance can also lead to a permanent desertion of active nests or of critical or preferred habitat, which could contribute to the relocation of a species or group to less favorable areas or to a decline of species through reproductive failure resulting from nest abandonment. When birds are flushed prior to or during migration, the energy cost could be great enough that they might not reach their destination on schedule or they may be more susceptible to diseases (Anderson, 1995).

Waterfowl are more overtly responsive to noise than other birds and seem particularly responsive to aircraft, possibly because aerial predators frequently harass them (Bowles, 1995). The FAA and corporate helicopter policy advise helicopters to maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Many undisturbed coastal areas and refuges provide preferred and/or critical habitat for feeding, resting (or staging), and nesting birds.

The effect of low-flying aircraft within the vicinity of aggregations of birds on the ground or on the water typically results in mass disturbance and abandonment of the immediate area. However, pilots traditionally have taken great pride in not disturbing birds. Compliance to the specified minimum altitude requirements greatly reduces effects of aircraft disturbance on coastal and marine birds. Routine presence of aircraft at sufficiently high altitudes results in acclamation of birds to routine noise. As a result of inclement weather, about 10 percent of helicopter trips would occur at altitudes somewhat below the minimums listed above. Although these incidents are seconds in duration and sporadic in frequency, they can disrupt coastal bird behavior and, at worst, possibly result in habitat or nest abandonment. Birds in flight over water typically avoid helicopters. Low-flying aircraft may temporarily disrupt feeding or flight paths. Routine presence and low speeds of service vessels within inland and coastal waterways would diminish the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. Birds can lose eggs and young when predators attack nests after parents are flushed into flight by service-vessel noise.

Air Quality Degradation

Contamination of wildlife by air emissions can occur in three ways: inhalation, absorption, and ingestion. Inhalation is the most common mode of contamination for birds (Newman, 1980). The major effects of air pollution include direct mortality, debilitating injury, disease, physiological stress, anemia, hypocalcemic condition, bioaccumulation of air pollutants with associated decrease in resistance to debilitating factors, and population declines (Newman, 1979). Direct effects can be either acute, such as sudden mortality from hydrogen sulfide, or chronic, such as fluorosis from fluoride emissions. The magnitude of effect, acute or chronic, is a function of the pollutant, its ambient concentration, pathway of exposure, duration of exposure, and the age, sex, reproductive condition, nutritional status, and health of the animal at the time of exposure (Newman, 1980). For metals in air emissions, chemical composition as well as size of particulate compounds has been shown to influence the toxicity levels in animals. Particulate size affects retention time and clearance from and deposition in the respiratory tract (Newman, 1981).

Levels of sulfur oxide (mainly sulfur dioxide, SO_2) emissions from hydrocarbon combustion from OCS-related activities are of concern in relation to birds. Research specific to birds has elucidated both acute and chronic effects from SO_2 inhalation (Fedde and Kuhlmann, 1979; Okuyama et al., 1979). Due to their lack of tracheal submucosal glands, birds appear to have more tolerance for inhaled SO_2 than most mammals (Llacuna et al., 1993; Okuyama et al., 1979). This suggestion stems from laboratory investigations where the test subject was the domestic chicken and results from these studies are not necessarily applicable to wild bird species. Acute exposure of birds to 100 ppm SO_2 produced no alteration in heart rate, blood pressure, lung tidal volume, respiratory frequency, arterial blood gases, or blood pH.

Exposure to 100 ppm or less of SO_2 did not affect respiratory mucous secretion. Exposure to 1,000 ppm SO_2 caused mucus to increase and drip from the mouths of birds, but lungs appeared normal. Exposure to 5,000 ppm resulted in gross pathological changes in airways and lungs, and then death (Fedde and Kuhlmann, 1979). Chronic (two week) exposure of birds to three concentrations of SO_2 for 16 hr/day for various total periods showed a statistical change in 10 cellular characteristics and resulted in cellular changes characteristic of persistent bronchitis in 69 percent of the tests done (Okuyama et al., 1979).

The indirect effects of air emissions on wildlife include food web contamination and habitat degradation, as well as adverse synergistic effects of air emissions with natural and other manmade stresses. Air emissions can cause shifts in trophic structure that alter habitat structure and change local food supplies (Newman, 1980).

Air pollutants may cause a change in the distribution of certain bird species (e.g., Newman, 1977; Llacuna et al., 1993). Migratory bird species will avoid potentially suitable habitat in areas of heavy air pollution in favor of cleaner areas if available (Newman, 1979). The abundance and distribution of passerine birds, both active and sedentary, and migratory species, as well as nonpasserine and nonmigratory varieties, are also greatly affected by natural factors such as weather and food supply.

Therefore, any reduction in the numbers of birds within a given locale does not have a diagnostic certainty pointing to air emissions (Newman, 1980).

Chapter 4.2.1.4 provides an analysis of the effects of a proposed action in the CPA on air quality. Emissions of pollutants into the atmosphere from the activities associated with a proposed action would have minimum effects on offshore and onshore air quality because of the prevailing atmospheric conditions, emission heights and rates, and pollutant concentrations. Estimated increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} would be less than 0.29, 0.03, and 0.01 micrograms/m^3, respectively, per modeled steady state concentrations. These concentrations are far below concentrations that could harm coastal and marine birds.

Water Quality Degradation

Chapter 4.2.1.3 provides an analysis of the effects of a proposed action in the CPA on water quality. Expected degradation of coastal and estuarine water quality resulting from of OCS-related discharges may affect coastal birds directly by means of acute or chronic toxic effects from ingestion or contact, or indirectly through the contamination of food sources. Operational discharges or runoff in the offshore environment could also affect seabirds (e.g., laughing gulls) that remain and feed in the vicinity of offshore OCS structures and platforms. These impacts could also be both direct and indirect.

Maintenance dredging operations remove several million cubic feet of material, resulting in localized impacts (primarily increased turbidity and resuspended contaminants) during the duration of the operations. Water clarity will decrease over time within navigation channels used for vessel operations and within pipeline canals due to continuous sediment influx from bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. A proposed action would result in very small incremental contribution to the need for channel maintenance. Coastal and marine birds that feed exclusively within these locations would likely experience chronic, sublethal physiological stress. Some coastal and marine birds would experience a decrease in viability and reproductive success that would be indistinguishable from natural population variations.

Habitat Degradation

The greatest negative impact to coastal and marine birds is loss or degradation of preferred or critical habitat. The extent of bird displacement resulting from habitat loss is highly variable between different species, based upon specific habitat requirements and availability of similar habitat in the area. Habitat requirements for most bird species are incompletely known. Generally, destruction of habitat from OCS pipeline landfalls and onshore construction displaces localized groups or populations of these species. As these birds move to undisturbed areas of similar habitat, their presence may augment habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space and food. Pipeline landfalls and terminals, and other onshore OCS-related construction, can destroy coastal bird feeding or nesting habitat and can displace coastal bird populations from affected areas. Onshore pipelines cross a wide variety of coastal environments, including freshwater marsh and canals, and can therefore affect certain species generally not associated with marine or estuarine systems. These include certain waders, marsh birds, shorebirds, and waterfowl.

The analysis of the potential impacts to coastal environments (Chapter 4.2.1.1) concludes that a proposed action in the CPA is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. Initial adverse impacts and more secondary impacts of pipeline and navigation canals are the most significant OCS-related and proposed-action-related impacts to wetlands. Initial impacts are locally significant and largely limited to where OCS-related canals and channels pass through wetlands. Secondary impacts may have substantial, progressive, and cumulative adverse impacts to the hydrologic basin or subbasin in which they are found.

Debris

Coastal and marine birds are susceptible to entanglement in floating, submerged, and beached marine debris; specifically in plastics discarded from both offshore sources and land-derived litter and waste disposal (Heneman and the Center for Environmental Education, 1988). Studies in Florida reported that

80 percent of brown pelicans showed signs of injury from entanglement with fishing gear (Clapp and Buckley, 1984). In addition, seabirds ingest plastic particles and other marine debris more frequently than do any other taxon (Ryan, 1990). Interaction with plastic materials may lead to permanent injuries and death. Ingested debris may have three basic effects on seabirds: irritation and blockage of the digestive tract, impairment of foraging efficiency, and release of toxic chemicals (Ryan, 1990; Sileo et al., 1990a). Effects of plastic ingestion may last a lifetime and may include physical deterioration due to malnutrition; plastics often cause a distention of the stomach, thus preventing its contraction and simulating a sense of satiation (Ryan, 1988). Some birds also feed plastic debris to their young, which could reduce survival rates. The chemical toxicity of some plastics can be high, posing a hazard in addition to obstruction and impaction of the gut (Fry et al., 1987). Sileo et al. (1990b) found that the prevalence of ingested plastic found within the gut of examined birds varied greatly among species. Species that seldom regurgitate indigestible stomach contents are most prone to the aforementioned adverse effects (Ryan, 1990). Within the Gulf of Mexico, these include the phalaropes, petrels, storm petrels, and shearwaters. It is expected that coastal and marine birds will seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics, garbage, and other solid wastes at sea or in coastal waters, went into effect January 1, 1989, and is enforced by the USCG.

Summary and Conclusion

The majority of effects resulting from a proposed action in the CPA on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal: behavioral effects, sublethal exposure to or intake of OCS-related contaminants or discarded debris, temporary disturbances, and displacement of localized groups from impacted habitats. Chronic sublethal stress, however, is often undetectable in birds. As a result of stress, individuals may weaken, facilitating infection and disease; then migratory species may not have the strength to reach their destination. No significant habitat impacts are expected to occur directly from routine activities resulting from a proposed action. Secondary impacts to coastal habitats will occur over the long-term and may ultimately displace species from traditional sites to alternative sites.

4.2.1.9. Impacts on the Gulf Sturgeon

Effects on Gulf sturgeon from routine activities associated with a proposed action in the CPA could result from degradation of estuarine and marine water quality, pipeline installation, and drilling and produced water discharges. Potential impacts from accidental oil spill are discussed in Chapter 4.4.3.9.

Proposed Action Analysis

Drilling mud discharges may contain chemicals that are toxic to Gulf sturgeon at concentrations four of five orders of magnitude higher than concentrations found a few meters from the discharge point. Offshore discharges of drilling muds are expected to dilute to background levels within 1,000 m of the discharge point.

Produced-water discharges may contain components potentially detrimental to Gulf sturgeon. Moderate heavy-metal and hydrocarbon contamination of sediments and the water column are expected to occur out to several hundred meters downcurrent from the discharge point (CSA, 1997b); however, offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m of the discharge point.

It is assumed that about 5 m^2 of sediments per kilometer of pipeline would be resuspended during the installation of 160-480 km of pipelines in water depths less than 60 m. Gulf sturgeon are expected to avoid lay-barge equipment and resuspended sediments.

Minor degradation of estuarine water quality is expected in the immediate vicinity of shorebases and other OCS-related facilities as a result of routine effluent discharges and runoff. Only a small amount of the routine dredging done in coastal areas will be directly or indirectly due to a proposed action.

Platform removal may kill some Gulf sturgeon, but the fish is not typically drawn to underwater structures.

Summary and Conclusion

Potential impacts on Gulf sturgeon may occur from resuspended sediments and OCS-related discharges, as well from non-point runoff from estuarine OCS-related facilities. The low toxicity of this pollution and almost absent overlap between individual Gulf sturgeon and occurrence of contamination is expected to result in little impact of a proposed action on Gulf sturgeon. Routine activities resulting from a proposed action in the CPA are not expected to have little potential effects on Gulf sturgeon.

4.2.1.10. Impacts on Fish Resources and Essential Fish Habitat

Effects on fish resources and essential fish habitat (EFH) from activities associated with a proposed action could result from coastal environmental degradation, marine environmental degradation, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters. Potential effects from routine activities resulting from a proposed action in the CPA on fish resources and EFH are described below. Potential effects on the three habitats of particular concern for Gulf of Mexico fish resources (the Flower Garden Banks National Marine Sanctuary, Weeks Bay National Estuarine Research Reserve in Alabama, and Grand Bay in Mississippi and Alabama) are included under the analyses for topographic features (Chapter 4.2.1.2.2) and wetlands (Chapter 4.2.1.1.2). Potential effects from accidental events (blowouts and spills) are described in Chapter 4.4.3.10. Potential effects on commercial fishing from a proposed action are described in Chapter 4.2.1.11.

Healthy fish resources and fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Because of the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for managed fish species in the CPA, the EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Since the majority of fish species within CPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. The environmental deterioration and effects on EFH and fish resources result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries within Texas, Louisiana, Mississippi, and Alabama may be affected by activities resulting from a proposed action (Chapters 4.2.1.1.2, 4.3.1.1.2, and 4.4.3.1.2). These activities include construction or expansion of onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (Chapters 4.2.1.3.1 and 4.4.3.3.1) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic and cause degradation of coastal water quality. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species within the CPA are dependent on offshore water and live bottoms, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH includes both high- and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Natural banks within the CPA are listed in Table 3-4. A detailed discussion of artificial reefs appears in Appendix 9.1.4. A proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Live Bottom (Pinnacle Trend) and Topographic Features Stipulations (Chapter 2.3.1.3) would prevent most of the potential impacts from a proposed action on pinnacle trend and live-bottom communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills.

Impact-producing factors from routine offshore activities that could result in marine water quality degradation include platform and pipeline installation, platform removal, and the discharge of operational wastes (Chapter 4.2.1.3.2). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter offshore water quality (Chapter 4.4.3.3.2). Coastal operations could indirectly affect marine water quality; offshore water quality can be impacted through migration of contaminated coastal waters (Chapter 4.2.1.3.1).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of production (Chapter 4.1.1.4). Seventy percent of the platforms in water depths less than 200 m are removed by severing their pilings with explosives placed 5 m below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991).

Within the past decade, stocks of reef fish have declined in the Gulf. There is concern over a possible connection between this decline and the explosive removal of platforms. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA and NMFS and has investigated fish death associated with structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the Gulf of Mexico. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the Gulf of Mexico (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small and would not alter current determinations of status or current management recovery strategies.

Chronic, low-level pollution is a persistent and recurring event resulting in frequent but sublethal physiological irritation to fish resources that lie within the range of impact and that are likely to be adversely affected by the pollution. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question (in this case hydrocarbons).

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the discharge plume disperses rapidly, is very near background levels at a distance of 1,000 m, and is usually undetectable at distances greater than 3,000 m (Kennicutt, 1995) (Chapter 4.1.1.3.4.1). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 part per million (ppm) and 3 ppm, respectively, in the stock barite used to make drilling muds. There has recently been increased media focus on mercury uptake in fish and other marine species. An MMS-funded study titled *Gulf of Mexico Offshore Operations Monitoring Experiment* (Kennicutt, 1995) analyzed sediments at three sites in the GOM. Results of this study indicated that mercury levels were slightly elevated in sediments or organisms at one platform site (High Island, East Addition, South Extension Block A-389 (HI A-389)). The average concentration of mercury at HI A-389 was twice as high as the other two platforms. The highest average concentration (0.41 ug/g) was found within 50 m of the platform but decreased to 0.12 ug/g at 100 m. Although these concentrations were the highest found, they were low relative to the probable effects level (0.7) believed to cause biological effects. This platform used the relatively rare practice of shunting drilling muds and cuttings to within 10 m of the seafloor to avoid dispersal and prevent impact to the nearby East Flower Garden Bank.

Metal concentrations were measured in tissues for 37 marine species. Fish tissue concentrations were generally low; for example, the average concentration was 0.45 ug/g for all flounder species, 0.39 ug/g all hake species, and 0.24 ug/g for all snapper species. Shrimp had statistically higher tissue concentrations (0.36 ug/g) near platforms than far (0.19 ug/g) from platforms. These values are well below the Federal guidelines set by the Food and Drug Administration (FDA) to protect human health, which is 1 ppm. Additional discussion of mercury in drilling muds can be found in Chapter 4.1.1.3.4.1.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m and are undetectable at a distance of 3,000 m from the discharge point (Harper, 1986; Rabalais et al., 1991; Kennicutt, 1995).

Proposed Action Analysis

The effects of a proposed action on coastal wetlands and coastal water quality, with the exception of accidental events, are analyzed in detail in Chapters 4.2.1.1.2 and 4.2.1.3.1, respectively. Collectively, the adverse impacts from these effects are called coastal environmental degradation in this EIS. The effects of a proposed action on offshore live bottoms and marine water quality are analyzed in detail in Chapters 4.2.1.2.1 and 4.2.1.3.2, respectively. Collectively, the adverse impacts from these effects are called marine environmental degradation in this EIS. The direct and/or indirect effects from coastal and marine environmental degradation on fish resources and EFH are summarized and considered below.

Coastal Environmental Degradation

A proposed action is projected to increase traffic in navigation channels to and from service bases from Texas to Alabama. This may result in some erosion of wetlands along the channels, particularly in Louisiana. Little erosion along the navigation channels in Mississippi and Alabama is expected because the channels are in upland areas and the banks are developed. Additional information regarding erosion along navigation channels is provided in the wetland analysis (Chapter 4.2.1.1.2).

One new pipeline landfall is projected in support of a proposed action. Depending on the site of this projected pipeline landfall, the activities associated with the installation could result in localized impacts to the coastal environment including degradation of water quality, and potential erosion and loss of wetlands habitat.

Localized, minor degradation of coastal water quality is expected in waterbodies in the immediate vicinity of coastal shore bases, commercial waste-disposal facilities, and oil refineries or gas processing plants as a result of routine effluent discharges and runoff. A proposed action in the CPA is projected to contribute about 2 percent of the OCS-Program-related use of these facilities.

Maintenance dredging of waterways and channels would result in decreased water clarity and some resuspension of contaminants. This could preclude, in rare instances, uses of those waters directly affected by the dredging operations for up to several months. The periods between projected dredging operations, ranging from 1-2 years, should generally allow for the recovery of affected areas. Only a small amount of the routine dredging done in coastal areas will be directly or indirectly due to a proposed action.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH. Wetlands that could be impacted for some period of time or converted to open water are discussed in the wetlands analysis (Chapter 4.2.1.1.2). Recovery of fish resources or EFH can occur from more than 99 percent, but not all, of the potential coastal environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation and most EFH can recuperate quickly, but the loss of wetlands as EFH could be permanent. At the expected level of effect, the resultant influence on fish resources or EFH from a proposed action would be negligible and indistinguishable from natural population variations.

Marine Environmental Degradation

The Live Bottom (Pinnacle Trend) and Topographic Features Stipulations would prevent most of the potential impacts on pinnacle-trend live-bottom or topographic-feature communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills resulting from a proposed action. For any activities associated with a proposed action, USEPA's Region 6 will regulate discharge requirements for the majority of the CPA through their NPDES permits. The USEPA's Region 4 would regulate a small area in the northeastern CPA, including the Mobile and Viosca Knoll lease areas. Contaminant levels in the CPA are generally low, reflecting the lack of pollution sources and high-energy environment of much of the region. The primary water quality impact from any increased turbidity would be decreased water clarity. Bottom disturbance from emplacement operations associated with a proposed action would produce localized, temporary increases in suspended sediment loading, resulting in decreased water clarity and little reintroduction of pollutants.

The major sources of discharges associated with a proposed action to marine waters are the temporary discharge of drilling muds and cuttings and the long-term discharge of produced-water effluent. Both of these discharges contain various contaminants of concern (e.g., trace metals and petroleum-based organic) that may have environmental consequences on marine water quality and aquatic life. Drilling mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than the concentrations found a few meters from the discharge point. Offshore discharges of drilling muds are expected to dilute to background levels within 1,000 m of the discharge point.

Produced-water discharges contain components and properties potentially detrimental to fish resources. Moderate petroleum and metal contamination of sediments and the water column are expected to occur out to several hundred meters downcurrent from the discharge point (CSA, 1997a). Offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m of the discharge point and amount to less than 1 percent of the annual harvest of surveyed commercial species.

The projected total number of platform installations resulting from a proposed action in the CPA is 28-49 for all water depths. Ten years after a platform is installed, the structure would be acting as an artificial reef. About 99 percent of the species present would be residents and not new transients from nearby live bottoms. All structures associated with a proposed action are expected to be removed by the year 2037. Structure removal results in loss of artificial-reef habitat and cause fish kills when explosives are used. Most multi-leg platforms in water depths less than 156 m are removed by severing their pilings with explosives placed 5 m below the seafloor. It is projected that 16-28 structures in water depths <200 m in the CPA will be removed using explosives as a result of a proposed action. It is expected that structure removals would have a negligible effect on fish resources because these activities kill only those fish proximate to the removal site.

The projected length of pipeline installations for a proposed action is 560-1,040 km. Trenching for pipeline burial has the potential to adversely affect fish resources. It is assumed that 5.02 m^2 of sediments per kilometer of pipeline would be resuspended during the installation of 160-480 km of pipelines in water depths less than 60 m. Where pipeline burial is necessary, a jetting sled is generally used. Water jets are directed downward to dig a trench and the apparatus can lay pipe at an average of 1.6 km/day (See Chapters 4.1.1.3.8.1 and 4.1.2.1.7 for additional discussion of pipelaying activities.). Sandy sediments would be quickly redeposited within 400 m of the trench or blowout site, and finer sediments would be widely dispersed and redeposited within a few thousand meters over a period of 30 days or longer. Any affected population is expected to recover to predisturbance condition in one generation. At the expected level of impact, the resultant influence on fish resources would be negligible and indistinguishable from other natural population variations.

It is expected that marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of marine environmental degradation is expected to cause an undetectable decrease in fish populations. Recovery of fish resources or EFH can occur from 100 percent of the potential marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation. Offshore live bottoms are not expected to be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by USEPA NPDES permits. At the expected level of effect, the resultant influence on fish resources or EFH would be negligible and indistinguishable from natural population variations.

Summary and Conclusion

It is expected that coastal and marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of coastal and marine environmental degradation is expected to cause an undetectable decrease in fish resources or in EFH. Fish resources and EFH are expected to recover from more than 99 percent, but not all, of the expected coastal and marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation, but any loss of wetlands as EFH would be permanent.

Offshore live bottoms will not be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by NPDES permits. At the expected level of impact, the resultant influence on fish resources and EFH would be negligible and indistinguishable from natural population variations.

Activities such as pipeline trenching and OCS discharge of drilling muds and produced water would cause negligible impacts and would not deleteriously affect fish resources or EFH. At the expected level of impact, the resultant influence on fish resources would cause less than a 1 percent change in fish populations or EFH. As a result, there would be little disturbance to fish resources or EFH.

A proposed action is expected to result in less than a 1 percent decrease in fish resources and/or standing stocks or in EFH. It would require one generation for fish resources to recover from 99 percent of the impacts. Recovery from the loss of wetlands habitat would probably not occur.

4.2.1.11. Impacts on Commercial Fisheries

Effects on commercial fishing from activities associated with a proposed action could result from installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, subsurface blowouts, pipeline trenching, and petroleum spills. Potential effects from routine activities resulting from a proposed action in the CPA on fish resources and EFH are described in Chapter 4.2.1.10. Potential effects from accidental events (spills and blowouts) are described in Chapter 4.4.3.11. Potential effects on commercial fishing from routine activities resulting from a proposed action are described below.

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for managed species in the CPA, the EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Since the majority of the commercial species harvested within the CPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and commercial fisheries. Environmental deterioration and effects on EFH and commercial fisheries result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries within Texas, Louisiana, Mississippi, and Alabama may be affected by activities resulting from a proposed action (Chapters 4.2.1.1.2 and 4.4.3.1.2). These activities include construction or expansion of onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (Chapters 4.2.1.3.1 and 4.4.3.3.1) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic and cause degradation of coastal water quality. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species harvested within the CPA are dependent on offshore water and live bottoms, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH includes both high- and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Natural banks within the CPA are listed in Table 3-4. A detailed discussion of artificial reefs appears in Appendix 9.1.4. A proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Live Bottom (Pinnacle Trend) and Topographic Features Stipulations (Chapter 2.3.1.3) would prevent most of the potential impacts from a proposed action on live-bottom communities/EFH from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills.

Impact-producing factors from routine offshore activities that could result in degradation of marine water quality include platform and pipeline installation, platform removal, and the discharge of operational wastes (Chapter 4.2.1.3.2). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter marine water quality (Chapter 4.4.3.3.2). Coastal operations could indirectly affect marine water quality; offshore water quality can be impacted through migration of contaminated coastal waters (Chapter 4.4.3.3.1).

The area occupied by structures, anchor cables, and safety zones associated with a proposed action would be unavailable to commercial fishermen and could cause space-use conflicts. Exploratory drilling rigs would spend approximately 30-150 days onsite and would cause short-lived interference to commercial fishing. A bottom-founded, major production platform in shallow water, with a surrounding 100-m navigational safety zone, requires approximately 6 ha of space. A floating production system in deeper water requires as much as 5 ha of space. The use of FPSO's is not projected for a proposed action, and the USCG has not yet determined what size of a navigational safety zone would be required for an FPSO during normal or offloading operations.

Underwater OCS obstructions, such as pipelines, can cause loss of trawls and catch, business downtime, and vessel damage. Pipelines in water depths less than 61 m (200 ft) are required to be buried, and their locations made public knowledge. Although Gulf fishermen are experiencing some economic loss from gear losses, the economic loss for a fiscal year has historically been less than 0.1 percent of the value of that same fiscal year's commercial fisheries landings. In addition, most financial losses from gear losses are covered by the Fishermen's Contingency Fund (FCF).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of production (Chapter 4.1.1.4). Seventy percent of the platforms in water depths less than 200 m are removed by severing their pilings with explosives placed 5 m below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991). Within the past decade, stocks of reef fish have declined in the Gulf. There is concern over a possible connection between this decline and the explosive removal of platforms. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA and NMFS and has investigated fish death associated with structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the Gulf of Mexico. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the Gulf of Mexico (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small, and would not alter current determinations of status or current management recovery strategies.

Chronic, low-level pollution is a persistent condition, resulting in frequent but sublethal physiological irritation to those resources that lie within the range of impact and that are likely to be adversely affected. The geographic range of the effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource.

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the plume disperses rapidly, is very near background levels at a distance of 1,000 m, and is usually undetectable at distances greater than 3,000 m (Kennicutt, 1995) (Chapter 4.1.1.3.4.1). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect commercial fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m and are undetectable at a distance of 3,000 m from the discharge point (Harper, 1986; Rabalais et al., 1991; Kennicutt, 1995).

Proposed Action Analysis

Installation of offshore structures may cause space-use conflicts with commercial fishing activities. The total projected number of production structure installation for a proposed action ranges from 28 to 49. Using the 100-m navigational safety zone figure (although to date very few operators have elected to apply to the USCG for a safety zone around production platforms), the possible area excluded from commercial trawl fishing or longlining would range from 168 to 294 ha. The maximum excluded area represents only a very small fraction (0.0015%) of the total area of the CPA. All structures associated with a proposed action are projected to be removed by the year 2037.

In water depths less than 200 m, the area of concentrated bottom trawl fishing, 23-39 platforms would be installed under a proposed action, eliminating 128-234 ha from the area available for commercial fishing. There is no use of FPSO's projected for a proposed action. It is assumed that space-use conflicts will seldom occur. The effect of space loss to trawl fishing resulting from the construction of platforms in support of a proposed action in the CPA would be negligible; the maximum extent of the area lost to commercial trawling would be less than 0.01 percent of the available trawl fishing area in water depths less than 200 m. Two large areas in the DeSoto Canyon Area have been designated by NOAA Fisheries as swordfish nursery areas and are closed to longline fishing activities. The boundaries of the closed areas are described in Chapter 3.3.1 and are shown on Figure 3-9. The longline closure areas are located largely in the EPA. A small portion of the northern closed area includes 174 blocks in the CPA in the Mississippi Canyon, Main Pass, Viosca Knoll, and Mobile lease areas. The closed areas cover nearly 845,000 km^2 and will displace commercial longlining, which may increase activity in the CPA and possibly the WPA.

Underwater OCS obstructions such as pipelines may cause fishing gear loss and additional user conflicts. The area of concentrated bottom trawl fishing is in water depths less than 200 m. For a proposed action, it is projected that 160-480 km of pipeline will be installed in water depths less than 60 m; no projection of the length of installed pipelines has been made for water depths of 60-200 m. Gear loss and user conflicts are mitigated by the FCF. Direct payments for claims in FY 1997 totaled $238,404 and total payments for FY 1998 were $311,290. The amount available for Gulf of Mexico FCF claims in FY 1999 was $1,212,969. The majority of claims are resolved within six months of filing. The economic loss from gear loss and user conflicts has historically been less than 0.1 percent of the same year's value of Gulf commercial fisheries landings. It is assumed that installed pipelines will seldom conflict with bottom trawl or other fishing activities, and they are expected to have a negligible effect on commercial fishing.

Structure removals result in loss of artificial-reef habitat and cause fish kills when explosives are used. It is projected that 16-28 structure removals using explosives will occur in water depths of <200 m as a result of a proposed action. It is expected that structure removals will have a negligible effect on commercial fishing because of the inconsequential number of removals and the consideration that removals kill only those fish proximate to the removal site.

Seismic surveys will occur in both shallow and deepwater areas of the CPA. Usually, fishermen are precluded from a very small area for several days. This should not impact the annual landings or value of landings for commercial fisheries in the Gulf. Gulf of Mexico species can be found in many adjacent locations and Gulf commercial fishermen do not fish in one locale. Loss of fishing gear because of seismic surveys are also mitigated (see above) by the FCF. All seismic survey locations and schedules are published in the USCG *Local Notice to Mariners,* a free publication available to all fishermen. Seismic surveys will have a negligible effect on commercial fishing.

Summary and Conclusion

Activities such as seismic surveys and pipeline trenching will cause negligible impacts and will not deleteriously affect commercial fishing activities. Operations such as production platform emplacement, underwater OCS impediments, and explosive platform removal, will cause slightly greater impacts on commercial fishing. At the expected level of impact, the resultant influence on commercial fishing will be indistinguishable from variations due to natural causes. As a result, there would be very little impact on commercial fishing. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It will require less than six months for fishing activity to recover from any impacts.

4.2.1.12. Impacts on Recreational Beaches

This section discusses the possible effects of a proposed action in the CPA on recreational beaches. Millions of annual visitors attracted to these resources are responsible for thousands of local jobs and billions of dollars in regional economic activity. Major recreational beaches are defined as those frequently visited sandy areas along the shoreline that are exposed to the Gulf of Mexico and that support a multiplicity of recreational activities, most of which is focused at the land and water interface. Included are Gulf Islands National Seashore, State parks and recreational areas, county and local parks, urban beaches, private resort areas, and State and private environmental preservation and conservation areas. The general locations of these beaches are indicated on MMS Visual 2—Multiple Use (USDOI, MMS, 2001d).

The primary impact-producing factors to the enjoyment and use of recreational beaches are trash and debris, and oil spills. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation, and noise from OCS-related aircraft can adversely affect a beach-related recreation experience. All these factors, either individually or collectively, may adversely affect the number and value of recreational beach visits. The potential impacts from oil spills and other accidental events are discussed in Chapter 4.4.3.12.

The value of recreation and tourism in the Gulf of Mexico coastal zone from Texas through Florida has been estimated in the tens of billions of dollars annually (USDOI, MMS, 2001g; pages III-101 and III-102). A significant portion of these expenditures is made in coastal counties, where major shoreline beaches are primary recreational attractions. Over one million people visit the mainland unit and barrier island beaches of the Gulf Island National Seashore in Mississippi and Florida annually, demonstrating the popularity of destination beach parks throughout the Gulf Coast region east of the Mississippi River. Trash and debris from OCS operations can wash ashore on Gulf of Mexico recreational beaches. Recreational beaches west of the Mississippi River are the most likely to be impacted by waterborne trash from OCS activities. Litter on recreational beaches from OCS operations could adversely affect the ambience of the beach environment, detract from the enjoyment of beach activities, and increase administrative costs on maintained beaches. Some trash items, such as glass, pieces of steel, and drums with chemical residues, can also be a health threat to users of recreational beaches. Current industry waste management practices; training and awareness programs focused on the beach litter problem; and the OCS industry's continuing efforts to minimize, track, and control offshore wastes are expected to minimize potential for accidental loss of solid wastes from OCS oil and gas operations.

The physical presence of platforms and drilling rigs visible from shore, and noise associated with vessels and aircraft traveling between coastal shore bases and offshore operation sites can adversely affect the natural ambience of primitive coastal beaches. Drilling rigs and platforms placed 3-10 mi from shore are within sight range of shoreline recreational beaches. Federal and State oil and gas operations are already occurring on nearshore tracts off Louisiana, Mississippi, and Alabama.

Although these factors may affect the quality of recreational experiences, they are unlikely to reduce the number of recreational visits to coastal beaches in the Central and Western Gulf.

Proposed Action Analysis

A proposed action in the CPA is projected to result in the drilling of 123-205 exploration and production wells and the installation of 19-33 platforms in water depths <60 m. In water depths of 60-200 m, a proposed action is projected to result in 58-107 wells and 4-6 platforms. Marine debris will be lost from time to time from OCS operations associated with drilling activities and production facilities projected to result from a proposed action in the CPA. Waste management practices and training programs are expected to minimize the level of accidental loss of solid wastes from activities resulting from a proposed action. Recreational beaches in Louisiana and Texas are most likely to be impacted by any waterborne trash. Beached litter and debris from a proposed action is unlikely to be perceptible to beach users or administrators because a proposed action would constitute only a small percentage of the total OCS Program activity in the CPA.

A proposed action is expected to result in 63,000-111,000 service-vessel trips over the life of the leases or about 1,575-2,775 trips annually. A proposed action is also expected to result in 220,000-870,000 helicopter trips, which is about 5,500-21,750 trips annually. Service vessels are assumed to use established nearshore traffic lanes and helicopters are assumed to comply with areal clearance restrictions at least 90 percent of the time. This additional helicopter and vessel traffic will add very little noise pollution likely to affect beach users.

Summary and Conclusion

Marine debris will be lost from time to time from operations resulting from a proposed action. The impact on Gulf Coast recreational beaches is expected to be minimal. The incremental increase in helicopter and vessel traffic is expected to add very little additional noise that may affect beach users. A proposed action is expected to result in nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses; however, these will have little effect on the number of beach users.

4.2.1.13. Impacts on Archaeological Resources

Blocks with a high probability for the occurrence of prehistoric, prehistoric and historic, or historic archaeological resources are found in the Central Gulf. Blocks with a high probability for prehistoric archaeological resources are found landward of a line that roughly follows the last geologic still-stand before inundation at approximately 13,000 B.P. (years before present). This 13,000-B.P. still-stand also roughly follows the 45-m bathymetric contour. Because of inherent uncertainties in both the depth of historic sea level stands and the entry date of prehistoric man into North America, MMS has adopted the 12,000 B.P. and 60-m water depth as the seaward extent of the high-probability area for prehistoric archaeological resources.

The areas of the northern Gulf of Mexico that are considered to have a high probability for historic period shipwrecks were redefined as a result of an MMS-funded study (Garrison et al., 1989; LTL's dated November 30, 1990, and September 5, 1995). The study expanded the shipwreck database in the Gulf of Mexico from 1,500 to more than 4,000 wrecks. Statistical analysis of shipwreck location data identified two specific types of high-probability areas—the first within 10-km of the shoreline and the second proximal to historic ports, barrier islands, and other loss traps. High-probability search polygons associated with individual shipwrecks were created to afford protection to wrecks located outside the two aforementioned high-probability areas (cf. Visual 3—Offshore Regulatory Features, USDOI, MMS, 2001e). The historic archaeological high-probability areas are under MMS review at the time of this writing. The MMS requires a 50-m remote-sensing, survey linespacing density for historic shipwreck surveys in water depths of 200 m or less. The current NTL – NTL 2002-G01, effective in March 2002 – supersedes all other archaeological NTL's and LTL's. The NTL updates requirements to reflect current technology.

An Archaeological Resources Stipulation was included in all Gulf of Mexico lease sales from 1974 through 1994. The stipulation was incorporated into operational regulations at 30 CFR 250.26 with few changes, and all protective measures offered in the Stipulation have been adopted in the regulation.

Additional supportive material for the archaeological resources analysis is provided in Chapter 3.3.2 (Description of the Affected Environment) and Chapters 4.2.1.13, 4.3.1.1.11, 4.4.3.13, and 4.5.13 (Environmental Consequences).

Several OCS-related, impact-producing factors may cause adverse impacts to archaeological resources. Offshore development could result in a drilling rig, platform, pipeline, dredging activity or anchors having an impact on an historic shipwreck. Direct physical contact with a wreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the period from which the ship dates.

The placement of drilling rigs and production platforms has the potential to cause physical impact to prehistoric and/or historic archaeological resources. It is assumed that the standard rig in less than 400 m of water will directly disturb 1.5 ha of soft bottom; the average platform under the same conditions, 2 ha. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

Pipeline placement has the potential to cause a physical impact to prehistoric and/or historic archaeological resources. Pipelines placed in water depths of less than 61 m must be buried. Burial depths of 1 m are required with the exception of shipping fairways and anchorage areas, where the requirements are 3.0 m and 4.6 m, respectively.

The dredging of new channels, as well as maintenance dredging of existing channels, has the potential to cause a physical impact to historic shipwrecks (Espey, Huston, & Associates, 1990a). There are many navigation channels that provide OCS access to onshore facilities. Most of these are located in the Central Gulf.

Anchoring associated with platform and pipeline emplacement, as well as with service-vessel and shuttle-tanker activities, may also physically impact prehistoric and/or historic archaeological resources. It is assumed that during pipeline emplacement, an array of eight 20,000-lb anchors is continually repositioned around the pipelaying barge.

Activities resulting from a proposed action will generate ferromagnetic structures and debris, which will tend to mask magnetic signatures of significant historic archaeological resources. The task of locating historic resources through an archaeological survey is, therefore, made more difficult as a result of leasing activity.

4.2.1.13.1. Historic Archaeological Resources

Proposed Action Analysis

The likely locations of archaeological sites cannot be delineated without first conducting a remote-sensing survey of the seabed and near-surface sediments. The MMS has issued regulations at 30 CFR 250.194, 250.203(b)(15), 250.203(o),. 250.204(b)(8)(v)(A), 250.204(s), and 250.1007(a)(5) that require OCS lessees and operators and applicants for pipeline rights-of-way to conduct an archaeological survey prior to proposed activities within areas determined to have a high probability for historic and/or prehistoric archaeological resources. Generally, in the eastern part of the CPA, where unconsolidated sediments are thick, it is likely that side-scan sonar will not detect shipwrecks buried beneath the mud. In this area, which begins nearshore around the Vermilion Area (USDOI, MMS, 1984) and extends eastward, the effectiveness of the survey for detecting historic shipwrecks of composite and wooden construction would depend on the capability of a magnetometer to detect ferromagnetic masses of the size characteristically associated with shipwrecks. It is assumed that the required 50-m line spacing (as specified in NTL 2002-G01) is a highly effective survey methodology, allowing detection of approximately 90 percent of historic shipwrecks within the survey area. The survey would therefore reduce the potential for an impact to occur by an estimated 90 percent.

According to estimates presented in Table 4-6, 289-599 exploration, delineation, and development wells will be drilled and 28-49 production platforms will be installed in support of a proposed action. Of these, 181-312 exploration, delineation, and development wells will be drilled, and 23-39 platforms will be installed in water depths of 200 m or less, where the majority of blocks with a high probability for historic period shipwrecks are located. The location of any proposed activity within a lease that has a high probability for historic shipwrecks requires archaeological clearance prior to operations. Considering that the expanded database contains 508 historic period shipwrecks in the entire Central Gulf OCS, the probability of an OCS activity contacting and damaging a shipwreck is very low. If an oil and gas structure contacted a historic resource, however, there could be a loss of significant or unique archaeological information.

Because there is only a thin Holocene sediment veneer overlying an overconsolidated Pleistocene surface in the western part of the CPA, shipwrecks are more likely to be detected by side-scan sonar; therefore, the 50-m survey linespacing is expected to be even more effective (95%) for reducing the potential for a direct physical contact between an impact-producing factor and a shipwreck in the western CPA. There is a very small possibility that a historic shipwreck could be impacted by OCS activities. Should such an impact occur, however, significant or unique archaeological information could be lost.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Sites already listed on the National Register of Historic Places and those considered eligible for the Register have already been evaluated as being able to make a unique or significant contribution to science. At present, unidentified historic sites may contain unique historic information and would have to be assessed after discovery to determine the importance of the data.

Onshore development could result in the direct physical contact between the construction of new onshore facilities or pipeline canals and previously unidentified historic sites. This direct physical contact with a historic site could cause physical damage to, or complete destruction of, information on the history of the region and the Nation. It is assumed that 2 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. Table 4-8 shows the projected coastal infrastructure related to OCS Program activities. Facilities that are projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or communities. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There is, therefore, no expected impact to onshore historic sites in the CPA from onshore development.

Maintenance dredging associated in support of activities resulting from a proposed action has the potential to impact a historic shipwreck. For instance, maintenance dredging in the Port Mansfield Entrance Channel is believed to impact the *Santa Maria de Yciar*, which sank on April 29, 1554 (Espey, Huston & Associates, 1990a) and is expected to impact the *SS Mary*, which sank on November 30, 1876, in Aransas Pass (Espey, Huston & Associates, 1990b). Impacts from maintenance dredging can be attributed proportionally to the users of the navigation channels. The MMS assessment indicates that, under a proposed action, less than 1 percent of the ship traffic through the Port Mansfield Cut is related to OCS use. Therefore, the impact to the *Santa Maria de Yciar* and *SS Mary* directly attributable to traffic and maintenance dredging as a result of the OCS Program is negligible. While the specific example falls within coastal Subarea TX-1, an area unlikely to be affected by activities resulting from a proposed action in the CPA, it serves to illustrate that the potential exists for historic shipwrecks to be impacted by dredging. As these shipwrecks are unique historic archaeological resources, maintenance dredging, in general, is responsible for impacts to historic shipwrecks. Proposed action activities represent <1 percent of the usage of the major navigation channels for the Central Gulf.

The loss of ferromagnetic debris during exploration and production activities has the potential to mask the magnetic signatures of historic shipwrecks. Under a proposed action, it is expected that hundreds of tons of ferromagnetic debris will be lost overboard. It is expected that most ferromagnetic debris associated with OCS structures will be removed from the seafloor during site-clearance activities. Site clearance, however, takes place after the useful life of the structure is complete. It has been noted that such debris has the potential to be moved from the area of initial deposition as a result of trawling activities (Garrison et al., 1989). Also, no site-clearance activities are required for pipeline emplacement operations. Therefore, there remains the potential for masking the signatures of historic shipwrecks as a result of ferromagnetic debris from OCS oil and gas activities.

Since all platform locations within the high-probability areas for the occurrence of offshore historic and prehistoric archaeological resources are given archaeological clearance prior to setting the structure, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structure Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

The greatest potential impact to a historic archaeological resource as a result of a proposed action in the CPA would result from direct contact between an offshore activity (platform installation, drilling rig emplacement, and dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Garrison et al., 1989) resulted in the redefinition of the high-probability areas for the location of historic period shipwrecks. An MMS review of the historic high-probability areas is occurring at the time of this writing. The NTL for archaeological resource surveys in the Gulf of Mexico Region, NTL 2002-G01, mandates a 50-m linespacing for remote-sensing surveys of leases within the high probability areas for historic shipwreck.

Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks.

Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under a proposed action is less than 1 percent.

Most other routine activities associated with a proposed action in the CPA are not expected to impact historic archaeological resources. It is conservatively assumed that about 2 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action (Table 4-8). It is expected that archaeological resources will be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities.

Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with a proposed action in the CPA are not expected to affect historic archaeological resources.

4.2.1.13.2. Prehistoric Archaeological Resources

Offshore development as a result of a proposed action could result in an interaction between a drilling rig, a platform, a pipeline, dredging, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy fragile artifacts or site features and could disturb artifact provenance and site stratigraphy. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

Proposed Action Analysis

According to projections presented in Table 4-2, under a proposed action, 289-599 exploration, delineation, and development wells will be drilled, and 28-49 production platforms will be installed as a result of a proposed action in the CPA. Relative-sea-level data for the Gulf of Mexico indicates that there is no potential for the occurrence of prehistoric archaeological sites in water depths greater than 60 m. If only the area likely to contain prehistoric sites (shallower than 60 m) is considered, 123-195 exploration, delineation, and development wells and 23-39 production platforms are projected to be installed (Table 4-2). The limited amount of impact to the seafloor throughout the CPA, the required archaeological survey, and archaeological clearance are sufficient to assume a low potential for impacting a prehistoric archaeological site. Should such an impact occur, damage to or loss of significant or unique prehistoric archaeological information could occur.

Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks. At present, unidentified onshore prehistoric sites would have to be assessed after discovery to determine the uniqueness or significance of the information that they contain. Sites already listed in the National Register of Historic Places and those considered eligible for the Register have already been evaluated as having the potential for making a unique or significant contribution to science. Of the unidentified coastal prehistoric sites that could be impacted by onshore development, some may contain unique information.

Onshore development as a result of a proposed action could result in direct physical contact between construction of new onshore facilities or a pipeline landfall and a previously unidentified prehistoric site. Direct physical contact with a prehistoric site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast region. It is assumed that 2 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. Table 4-8 shows the projected coastal infrastructure related to OCS Program activities. Each facility projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There should, therefore, be no impact to onshore CPA prehistoric sites from onshore development related to a proposed action.

Each platform location within the high-probability areas for the occurrence of historic and prehistoric archaeological resources requires archaeological clearance prior to setting the structure; therefore, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structural Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

Several impact-producing factors may threaten the prehistoric archaeological resources of the Central Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a lease are expected to be highly effective (90%) at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant and/or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

A proposed action in the CPA is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

4.2.1.14.Impacts on Human Resources and Land Use

This proposed action analysis considers the effects of OCS-related, impact-producing activities from a proposed CPA lease sale in relation to the continuing baseline of non-OCS-related factors. Non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity from State waters, wetland loss, and tropical storms. Unexpected events that may influence oil and gas activity within the analysis area but that cannot be predicted are not considered in this analysis.

4.2.1.14.1. Land Use and Coastal Infrastructure

Proposed Action Analysis

Chapters 3.3.3.3 and 3.3.3.8 discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. The existing oil and gas infrastructure is expected to be sufficient to handle development associated with a proposed action. A proposed CPA lease sale would not alter the current land use of the area.

Summary and Conclusion

A proposed action in the CPA would not require additional coastal infrastructure or alter the current land use of the analysis area.

4.2.1.14.2. Demographics

In this section, MMS projects how and where future demographic changes will occur and whether they correlate with a proposed CPA lease sale. The addition of any new human activity, such as oil and gas development resulting from a proposed action, can affect local communities in a variety of ways. Typically, these effects are in the form of people and money, which can translate into changes in the local social and economic institutions and land use.

Proposed Action Analysis

Population

Population projections related to activities resulting from a proposed action are expressed as total population numbers and as a percentage of the population levels that would be expected if the proposed lease sale was not held (Tables 4-29 and 4-30). Chapter 3.3.3.4.1 discusses baseline population projections for the analysis area. Because the baseline projections assume the continuation of existing social, economic, and technological trends, they also include population changes associated with the continuation of current patterns in OCS Program activities. Population impacts from a proposed action in the CPA mirror the assumptions for employment impacts described in Chapter 4.2.1.14.3 below. Projected population changes reflect the number of people dependent on income from OCS-related employment for their livelihood, which is based on the ratio of population to employment in the analysis area over the life of a proposed lease sale. Note that Subareas LA-1, LA-2, LA-3, and MA-1 correspond to the offshore CPA; TX-1 and TX-2 correspond to the WPA; and FL-1, FL-2, FL-3 and FL-4 correspond to the EPA.

Population associated with a proposed CPA lease sale is estimated at about 14,200-20,700 persons during the peak year of impact (year 11) for the low- and the high-case scenarios, respectively. While population associated with a typical CPA lease sale as proposed is projected to peak in year 11, year 6 also displays close to peak levels of population. During the years of peak or near-peak population, a substantial amount of platform and pipeline installations are projected in association with a proposed CPA lease sale. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently, therefore, leading to employment and population impacts.

Population impacts from a proposed action in the CPA are expected to be minimal, i.e., less than 1 percent of total population for any coastal subarea. The mix of males to females is expected to remain unchanged. The increase in employment is expected to be met primarily with the existing population and available labor force with the exception of some in-migration (some of whom may be foreign) projected to move into focal areas, such as Port Fourchon.

Age

If a proposed CPA lease sale is held, the age distribution of the analysis area is expected to remain virtually unchanged. Given both the low levels of population growth and industrial expansion associated with a proposed action, the age distribution pattern discussed in Chapter 3.3.3.4.2 is expected to continue through the year 2040. Activities relating to a proposed action in the CPA are not expected to affect the analysis area's median age.

Race and Ethnic Composition

The racial distribution of the analysis area is expected to remain virtually unchanged if a proposed CPA lease sale is held. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the racial distribution pattern described in Chapter 3.3.3.4.3 is expected to continue through the year 2040.

Education

Activities relating to a proposed CPA lease sale are not expected to significantly affect the analysis area's educational levels. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the analysis area's education status, described in Chapter 3.3.3.4.4, is expected to continue through the year 2040. Activities relating to a proposed action in the CPA are not expected to affect the analysis area's educational attainment.

Summary and Conclusion

Activities relating to a proposed CPA lease sale are expected to minimally affect the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one subarea. Baseline patterns and distributions of these factors, as described in Chapter 3.3.3, are expected to maintain. Changes in land use throughout the analysis area are expected to be contained and minimal. The OCS-related infrastructure is in place and will not change as a result of a proposed action. Current baseline estimates of population growth for the analysis area show a continuation of growth, but at a slower rate.

4.2.1.14.3. Economic Factors

The importance of the oil and gas industry to the coastal communities of the Gulf of Mexico is significant, particularly in south Louisiana, eastern Texas, and coastal Alabama. Dramatic changes in the level of OCS oil and gas activity over recent years have resulted in parallel fluctuations in population, labor, and employment in the analysis area. The economic analysis for a proposed lease sale in the CPA focuses on the potential direct, indirect, and induced impacts of the OCS oil and gas industry on the population and employment of the counties and parishes in the analysis region defined in Chapter 3.3.3.1. To improve regional economic impact assessments and to make them more consistent with each other, MMS developed a new methodology for estimating changes to employment and other economic factors.

The methodology developed to quantify these impacts on population and employment takes into account changes in OCS-related employment, along with population impacts resulting from these employment changes within each individual subarea.

The Gulf of Mexico region model has two steps.

(1) Because there are no publicly available models that estimate the expenditures resulting from offshore oil and gas activities, the model first estimates expenditures for 10 scenario activities projected to result from a proposed action in the CPA. These activities include exploratory drilling, development drilling, production operations and maintenance, platform fabrication and installation, pipeline construction, pipeline operations and maintenance, gas processing and storage construction, gas processing and storage operations and maintenance, workovers, and platform removal and abandonment. The model then assigns these expenditures to industrial sectors in the 10 subareas defined in Chapter 3.3.3.1.

(2) The second step in the model uses multipliers from the commercial input-output model IMPLAN (using 1999 data, the latest available data) to translate these expenditures into direct, indirect, and induced employment and other economic factors. Direct employment results from the first round of industry spending. It is the employment that results from the initial dollars spent by the oil and gas industry on the 10 scenario activities (listed above). Indirect employment results as the initial spending reverberates through the economy. First, the suppliers of the goods and services for the 10 activities spend the initial direct dollars from the industry. Then, these dollars are re-spent by other suppliers until the initial dollars have trickled throughout the economy. Households spending the resulting labor income creates induced employment.

Both the level (the amount spent) and the sectoral (the industry in which it is spent) allocation of expenditures can vary considerably by the phase of OCS activity and by the water depth of the OCS activities. For example, an exploratory well in 0-60 m of water is expected to be drilled using a jack-up rig and cost about $4 million, whereas an exploratory well in 800 m or greater water depth is expected to be drilled using a drillship and to cost in excess of $10 million to complete. In addition, spending on materials such as steel will be much higher for platform fabrication and installation than for operations and maintenance once production begins. Therefore, the model estimates and allocates expenditures for the 10 scenario activities in four water-depth categories: 0-60 m, 61-200 m, 201-800 m, and >800 m. Because local economies vary, a separate set of IMPLAN multipliers is used for each coastal subarea to which expenditures are assigned. Each set of multipliers is based on the actual historical patterns of economic transactions in the area. Model results for employment are presented in the number of jobs per year, where one job is defined as a year of employment. This does not necessarily mean only one person occupies the position through out the year. One job may be equal to two part-time positions occupied over the year or one person occupying a position for 6 months, while another person occupies it for the other 6 months.

The projections in this section are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Because energy markets are complex, models are simplified representations of energy production and consumption, regulations, and producer and consumer behavior. Projections are highly dependent on the data, methodologies, model structures, and assumptions used in their development. Energy projections are subject to much uncertainty. Many of the events that shape energy markets are random and cannot be anticipated, including severe weather, political disruptions, strikes, and technological breakthroughs. In addition, future developments in technologies, demographics, and resources cannot be foreseen with any degree of certainty. Given this, MMS has endeavored to make these projections as objective, reliable, and useful as possible (USDOE, EIA, 2001b).

Proposed Action Analysis

Total employment projections for activities resulting from a proposed action are expressed as absolute numbers and as a percentage of the employment levels expected if no development occurs (Tables 4-31 and 4-32). Note that coastal Subareas LA-1, LA-2, LA-3, and MA-1 correspond to the offshore CPA; Subareas TX-1 and TX-2 correspond to the offshore WPA; and Subareas FL-1, FL-2, FL-3, and FL-4 correspond to the EPA. The baseline projections of population and employment used in this analysis are described in Chapters 3.3.3.4 and 3.3.3.5 (Tables 3-12 to 3-27). Because these baseline projections assume the continuation of existing social, economic, and technological trends, they also include employment resulting from the continuation of current patterns in OCS Program activities. Population impacts, described in Chapter 4.2.1.14.2 (Tables 4-29 and 4-30), mirror those assumptions associated with employment. Projected population changes reflect the number of people dependent on income from oil- and gas-related employment for their livelihood. This figure is based on the ratio of population to employment in the impact region over the life of a proposed lease sale.

Based on model results, direct employment associated with a proposed CPA lease sale is estimated at about 4,700-6,900 jobs during peak impact year 11 for the low- and high-case scenarios, respectively. Indirect employment is projected at about 1,700-2,500 jobs, while induced employment is calculated to be about 1,900-2,800 jobs, for the low- and high-case scenarios, respectively. Therefore, total employment resulting from a proposed CPA lease sale is not expected to exceed 8,300-12,200 jobs in any given year over a proposed action's 40-year lifetime. While employment associated with a proposed CPA lease sale is projected to peak in year 11, year 6 also displays close to peak levels of employment. The projected peak years for platform and pipeline installation activities in support of a proposed action determine the periods of peak or near-peak employment. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently.

Although most of the employment related to a proposed action is expected to occur in Subarea TX-2, employment is not expected to exceed 1 percent of the total employment in any given subarea of Texas, Louisiana, Mississippi, or Alabama (Table 4-32). On a percentage basis, Subarea LA-1is projected to have the greatest employment impact at 0.3 percent; Subareas LA-2, LA-3, and MA-1 are projected to have the next greatest employment impacts at 0.2 percent each. Considering Florida's current opposition to oil and gas development in offshore waters and the scarcity, if not absence, of onshore supporting service bases, MMS anticipates that very few OCS-related activities will be staged from Florida. Model results concur there would be little to no economic stimulus to the Florida analysis region as a result of a proposed CPA lease sale.

Summary and Conclusion

Should a proposed CPA lease sale occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, and Alabama subareas. A proposed action is expected to generate less than a 1 percent increase in employment in any of these subareas. This demand will be met primarily with the existing population and available labor force. There would be very little to no economic stimulus in the Florida subareas.

While a proposed CPA lease sale will not significantly impact the analysis area, OCS activities from past and future OCS lease sales will continue to occur and impact the analysis area. In other words, even if a proposed action were not held, there would still be impacts from past and future OCS lease sales in the analysis area. The OCS-related impacts will continue even in the absence of a proposed action.

4.2.1.14.4. Environmental Justice

The analysis of environmental justice concerns is divided into those related to routine operations (below) and those related to oil spills (Chapter 4.4.3.14.2). Concerns related to routine operations center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). Chapter 3.3.3.5 describes the widespread presence of an extensive OCS support system and associated labor force, as well as economic factors related to OCS activities. The MMS estimates that production from a proposed action in the CPA will be 0.276-0.654 BBO and 1.590-3.300 tcf of gas.

Proposed Action Analysis

Environmental justice issues involve questions of disproportionate and negative effects on minority and low-income populations. A proposed action in the CPA is expected to increase slightly employment opportunities in a wide range of businesses along the Gulf Coast. These conditions preclude a prediction of where much of this employment will occur or who will be hired. Figures 3-15 and 3-16 provide distributions of census tracts of high concentrations of minority groups and low-income households. As stated in Chapter 3.3.3.11, pockets of concentrations of these populations are scattered throughout the Gulf of Mexico coastal counties and parishes. Many of these populations are in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. Low-income populations are almost exclusively minority and urban. Because the distribution of low-income and minority populations does not parallel the distribution of industry activity, effects of a proposed action are not expected to be disproportionate.

The widespread economic effects of a proposed action on minority and low-income populations are not expected to be negative. Ongoing MMS research includes gathering information on race and employment. Offshore workers in the production sector are almost entirely male and white (Rosenberg, personal communication, 2001). Other sectors, such as the fabrication industry and support industries (e.g., trucking), employ minority workers and provide jobs across a wide range of pay levels and educational/skill requirements (Austin et al., 2002a and b; Donato et al., 1998). A study of oil industry trends between 1980 and 1990 found that downsizing was concentrated in the production sector; therefore, it affected white male employment more than that of women or minorities (Singelmann, in press). Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One MMS study in Louisiana found income inequality decreased during the oil boom and increased with the decline (Tolbert, 2001). Another MMS-funded study found that reemployment rates for poorly educated black and white women laid off in the closing of an OCS-related plant in one rural town were much higher than reemployment rates related to similar closings elsewhere because Louisiana's oil industry had created a complex local economy (Tobin, 2001). While a proposed action will provide little additional employment, it will have the effect of maintaining current activity levels, which is expected to be beneficial to low-income and minority populations.

Environmental justice often concerns the possible siting of infrastructure in places that will have disproportionate and negative effects on minority and low-income populations. Since a proposed action will help to maintain ongoing levels of activity rather than expand them, no one proposed lease sale will generate significant new infrastructure demand. For this reason, this EIS considers infrastructure projections only for the cumulative analysis (Chapter 4.4.3.14.4). The cumulative analysis concludes that, as with the analysis of employment effects of a proposed action, infrastructure effects are expected to be widely and thinly distributed. Since the siting of new infrastructure will reflect the distribution of the petroleum industry and not that of minority and low-income populations, the OCS activity in the CPA is not expected to disproportionately effect these populations. Again, Lafourche Parish is identified as a location of more concentrated effects. Each OCS-related facility constructed onshore must first receive approval by the relevant Federal, State, county or parish, and community involved, and MMS assumes that new construction will be approved only if consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms.

Because of Louisiana's extensive oil-related support system (Chapter 3.3.3.5.1), that State is likely to experience more employment effects related to a proposed action in the CPA than are the other coastal states. Lafourche Parish, Louisiana, is likely to experience the greatest concentration and is the only parish where the additional OCS-related activities and employment are sufficiently concentrated to increase stress to its infrastructure. Even so, the effects of a proposed action are not expected to be significant in the long term.

The concentrated socioeconomic impacts in Lafourche Parish are not expected to have disproportionate effects on minority and low-income populations for several reasons. The parish is not predominately minority or low income (Figures 3-15 and 3-16). The Houma, a Native American tribe recognized by the State of Louisiana, have been identified by MMS as a possible environmental justice concern. The MMS is currently funding a study focused on Lafourche Parish and the Houma, although available information indicates that the Houma are not expected to be disproportionately affected because they are not residentially segregated but, rather, live interspersed among the nonminority population (Fischer, 1970).

Two local infrastructure issues described in Chapter 3.3.3.2 could possibly have related environmental justice concerns—traffic on LA Hwy. 1 and the Port Fourchon expansion. The most serious concern raised during scoping for this multisale EIS is the high-level of traffic on LA Hwy. 1. Increased traffic may have health risks (e.g., increased accident rates). As described in Chapter 3.3.3.1, human settlement patterns in the area (on high ground along LA Hwy. 1 and Bayou Lafourche) mean that rich and low-income alike would be affected by any increased traffic. Port Fourchon is relatively new and is surrounded by mostly uninhabited land. Existing residential areas close to the port are also new and not considered low-income areas. Any expansion of infrastructure at Port Fourchon is not expected to disproportionately affect minority or low-income populations. Lafourche Parish is an area of relatively low unemployment because of the concentration of petroleum-related industry in the area (Hughes, in press). While the minority and low-income populations of Lafourche Parish will share with the rest of the parish population any negative impacts related to a proposed action in the CPA, most effects related to a proposed action would be economic and positive.

Summary and Conclusion

Because of the existing extensive and widespread support system for OCS-related industry and associated labor force, the effects of a proposed action in the CPA are expected to be widely distributed and little felt. In general, who will be hired and where new infrastructure might be located is impossible to predict. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on low-income and minority populations. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, a proposed action is not expected to have a disproportionate effect on these populations.

Lafourche Parish will experience the most concentrated effects of a proposed action; however, because the Parish is not heavily low-income or minority, because the Houma are not residentially segregated, and because the effects of road traffic and port expansion will not occur in areas of low-income or minority concentration, these groups will not be differentially affected. In general, the effects in Lafourche Parish are expected to be mostly economic and positive. A proposed action would help to maintain ongoing levels of activity rather than expand them. Future changes in activity levels will most likely be caused by fluctuations in oil prices and imports, and not by activities related to a proposed action. A proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

4.2.2. Alternative B – The Proposed Actions Excluding the Blocks Near Biologically Sensitive Topographic Features

Description of the Alternative

Alternative B differs from Alternative A (proposed action) by not offering the 34 unleased blocks of the 167 total blocks that are possibly affected by the proposed Topographic Features Stipulation (Chapter 2.3.1.3.1). All of the assumptions (including the two other potential mitigating measures) and estimates are the same as for a proposed action (Alternative A). A description of Alternative A is presented in Chapter 2.3.1.1.

The Federal offshore area is divided into subareas based on water depths in meters (C0-60, C60-200, C200-800, C800-1600, C1600-2400, and C>2400), and the adjacent coastal region is divided into four coastal subareas (LA-1, LA-2, LA-3, and MA-1). These subareas are delineated on Figure 4-1.

Effects of the Alternatives

The following analyses are based on the scenario for a proposed action in the CPA (Alternative A). The scenario provides assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. These are estimates only and not predictions of what will happen as a result of holding a proposed sale. A detailed discussion of the scenario and related impact-producing factors is presented in Chapter 4.1.

The analyses of impacts to the various resources under Alternative B are very similar to those for Alternative A. The reader should refer to the appropriate discussions under Alternative A for additional and more detailed information regarding impact-producing factors and their expected effects on the various resources. Impacts under Alternative B are expected to be the same as those under a typical proposed action in the CPA (Chapter 4.2.1) for the following resources:

–Sensitive Coastal Environments
–Sensitive Offshore Resources
–Live Bottoms (Pinnacle Trend)
–Deepwater Benthic Communities
–Water Quality
–Air Quality
–Marine Mammals
–Alabama, Choctawhatchee, and Perdido Key Beach Mice
–Coastal and Marine Birds
–Gulf Sturgeon
–Fish Resources and Essential Fish Habitat
–Commercial Fisheries
–Recreational Beacheshes
–Archaeological Resources
–Socioeconomic Conditions

The impacts to some Gulf of Mexico resources under Alternative B would be different from the impacts expected under a proposed action. These impacts are described below.

Impacts on Sensitive Offshore Resources

Topographic Features

The sources and severity of impacts associated with this alternative are those sale-related activities discussed for a proposed action. As noted in Chapter 4.2.1.2.2, the potential impact-producing factors to the topographic features of the Central Gulf are anchoring and structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. A more detailed discussion of these potential impact-producing factors is presented in Chapter 4.2.1.2.2.

All of the 16 topographic features of the Central Gulf are located within water depths less than 200 m. These features occupy a very small portion of the entire area. Of the potential impact-producing factors that may affect the topographic features, anchoring, structure emplacement, and structure removal will be eliminated by the adoption of this alternative. Effluent discharge and blowouts will not be a threat to the topographic features because blocks near enough to the banks for these events to have an impact on the biota of the banks will have been excluded from leasing under this alternative. Thus, the only impact-producing factor remaining from operations in blocks included in this alternative (i.e., those blocks not excluded by this alternative) is an oil spill. The potential impacts from oil spills are summarized below and are discussed further in Chapter 4.4.3.2.2.

A subsurface spill would have to come into contact with a biologically sensitive feature to have an impact. The chance of one or more subsurface pipeline spills ≥1,000 bbl occurring in the Central Gulf is 32-59 percent. The chance of a substantial amount of oil being release during a blowout is less than 8 percent. A subsurface spill is expected to rise to the surface, and any oil remaining at depth will be swept clear of the banks by currents moving around the banks (Rezak et al., 1983). Deepwater subsurface spills may travel along the sea bottom or in the water column for some distance before rising to the surface. The fact that the topographic features are widely dispersed in the Central Gulf, combined with the random nature of spill events, would serve to limit the likelihood of a spill occurring proximate to a topographic feature. Chapter 4.4.1.1.8 discussed the risk of spills interacting with topographic features, especially the Flower Garden Banks, in more detail. The currents that move around the banks will likely steer any spilled oil around the banks rather than directly upon them, lessening impact severity. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for most of the adult sessile biota. Lethal effects would probably be limited to a few coral colonies (in the case of the Flower Garden Banks National Marine Sanctuary) (CSA, 1992b and 1994). It is anticipated that recovery from a mostly sublethal exposure would occur within a period of 2 years. In the unlikely event that oil from a subsurface spill contacted a coral-covered area (in the case of the Flower Garden Banks), the areal extent of coral mortality would be limited, but long-lasting sublethal effects may be incurred by organisms surviving the initial effects of a spill (Jackson et al., 1989). Indeed, the stress resulting from the oiling of reef coral colonies could affect their resilience to natural disturbances (e.g., elevated water temperature, diseases) and may hamper their ability to reproduce. A complete recovery of such an affected area could take in excess of 10 years.

Conclusion

Alternative B is expected to cause little or no damage to the physical integrity, species diversity, or biological productivity of the habitats of the topographic features. In the unlikely event that oil from a subsurface spill contacts the biota of a topographic feature, the effects would be localized and primarily sublethal for most of the adult sessile biota. Some lethal effects would probably occur upon oil contact to coral colonies (in the case of the Flower Garden Banks National Marine Sanctuary); recovery from such an event is anticipated to occur within a period of 2 years.

Impacts on Sea Turtles

The level of activity associated with Alternative B is the same as the infrastructure and activity described for a proposed action (Chapter 4.1 and Table 4-2). The sources and severity of impacts to sea turtles under Alternative B are the same as under a proposed action (Chapter 4.2.1.6). The major impact-producing factors related to Alternative B that may affect Gulf sea turtles, including structure installation, dredging, operational discharges, and explosive platform removals, would not occur within the area excluded under Alternative B. The effects of these activities would occur in the remainder of the CPA and are expected to be primarily nonlethal, with few lethal impacts; the probability of an interaction is low.

Conclusion

Alternative B is expected to temporarily disturb some sea turtles and their habitats; however, it is unlikely to have significant long-term adverse effects on the size and productivity of any turtle species or population stock in the northern Gulf of Mexico.

4.2.3. Alternative C — The Proposed Action Excluding Unleased Blocks within 15 Miles of the Baldwin County, Alabama, Coast

Description of the Alternative

Alternative C differs from Alternative A (a proposed action) by not offering any unleased blocks within 15 mi of the Baldwin County, Alabama, coast (as of January 1997, 6 blocks were unleased). All the assumptions (including potential mitigating measures) and estimates are the same those under Alternative A (Chapters 2.3.1.3 and 4.1.1). A description of Alternative A is presented in Chapter 2.3.1.1.

The Federal offshore area is divided into subareas based on water depths in meters (C0-60, C60-200, C200-800, C800-1600, c1600-2400, and C>2400). The coastal region adjacent to the area considered under Alternative C is designated coastal Subarea MA-1. These subareas are delineated on Figure 4-1.

Effects of the Alternatives

The following analyses are based on the scenario for a proposed action in the CPA (Alternative A). A detailed discussion of the scenario and related impact-producing factors is present in Chapter 4.1.

The analyses of impacts to the various resources under Alternative C are very similar to those for Alternative A. The reader should refer to the appropriate discussions under Alternative A for additional and more detailed information regarding impact-producing factors and their effects on the various resources. Impacts are expected to be the same as those estimated under a typical proposed action in the CPA (Chapter 4.2.1) for the following resources:

–Sensitive Coastal Environments
–Sensitive Offshore Resources
–Live Bottoms (Pinnacle Trend and Topographic Features)
–Deepwater Benthic Communities
–Air Quality
–Marine Mammals
–Alabama, Choctawhatchee, and Perdido Key Beach Mice
–Coastal and Marine Birds
–Gulf Sturgeon
–Commercial Fisheries
–Socioeconomic Conditions

Impacts to some Gulf of Mexico resources would be different from the impacts of a proposed action. These impacts are described below.

Impacts on Water Quality

Bottom-area disturbance resulting from platform emplacement and removal, drilling activities, and blowouts result in some level of increased water-column turbidity in overlying offshore waters. Generally, each of these operations has been shown to produce localized, temporary impacts on water quality conditions in the immediate vicinity of the emplacement operation (Chapter 4.1.1.3.2). Alternative C would eliminate impacts associated with platform emplacement in the areas within 15 mi off the coast of Baldwin County, Alabama.

The oil-spill events related to a proposed action under Alternative A were projected to be mostly very small events, to be very infrequent for spills greater than 50 bbl, to have effects for only a short-duration (from a few days to three months), and to affect only a small area of offshore waters at any one time (Chapter 4.4). These events would not be eliminated as a result of Alternative C. The risk of spills due to exploration and development would be eliminated within the deferral area.

Conclusion

Bottom disturbances from platform emplacements and removals, drilling activities, and blowouts would not occur within the excluded area under Alternative C. Localized, temporary impacts to water quality due to sediment resuspension would be eliminated in the area within 15 miles of the Baldwin County coast, if Alternative C is adopted. Additionally, the risk of oil-spill impacts would be slightly reduced as exploration and development operations would not occur in the excluded area.

Impacts on Sea Turtles

The major impact-producing factors that may affect Gulf sea turtles, including structure installation, dredging, operational discharges, and explosive platform removals, would not occur within the excluded area. The effects of these activities would occur in the remainder of the CPA and are expected to be primarily nonlethal, with few lethal impacts; the probability of an interaction is low.

Conclusion

Alternative C is expected to temporarily disturb some sea turtles and their habitats, but deaths are expected to be rare. All disturbances are expected to be temporary, and sea turtles are expected to recover from within a period of weeks to months.

Impacts on Archaeological Resources

As a result of a typical proposed action in the CPA, Federal waters offshore Alabama were assumed to have new exploration, delineation, and development wells drilled. There would be platform installations and pipelines laid in the area. The location of any proposed activity within a lease block that has a high probability for historic shipwrecks requires archaeological clearance prior to operations. The probability of an OCS activity contacting and damaging a shipwreck is low; the required clearance measures are considered to be 90 percent effective at protecting potential unknown historic shipwrecks. If an OCS structure did contact a historic resource, unique archaeological information contained within a site or resource could be lost. Under Alternative C, drilling activities and installation of platforms within

15 mi of the shoreline of Baldwin County, Alabama, would not occur. Any potential impacts from drilling activities or platform emplacement to historic shipwrecks would be eliminated in OCS blocks within 15 mi of the Baldwin County shoreline.

Conclusion

The probability of an OCS activity contacting and damaging a shipwreck is low because of existing mitigation in the form of archaeological clearance requirements for proposed activities. Alternative C would eliminate the potential for impacts from drilling or platform emplacement to historic archaeological resources within the area excluded under Alternative C.

Impacts on Recreational Beaches

The major impact-producing factors that could potentially affect recreational beaches include the presence of offshore structures, pipelaying activities, support helicopter and vessel traffic, trash and debris, and oil spills. Exploratory rig activity and platforms associated with OCS development activity could be viewed from coastal communities along the Gulf of Mexico when they are closer than approximately 10 mi from shore; beyond that, structures appear very small and barely discernable to the naked eye, eventually disappearing from view. Alternative C would exclude those blocks within 15 mi of the shoreline from leasing. No OCS structures would be constructed within the excluded area. Any visual impact due to OCS structures in the area off Baldwin County, Alabama, would be eliminated. Pipelaying activities, support helicopter and vessel traffic, trash and debris, and oil spills from the remaining areas offered from lease would continue to present potential impacts to recreational beaches.

Conclusion

Alternative C would exclude blocks within 15 mi of the Baldwin County, Alabama, coast from leasing. No OCS structures would be constructed within the excluded area. Therefore, any visual impact due to OCS structures in the area off Baldwin County would be eliminated.

4.2.4. Alternative D — No Action

Description of the Alternative

Alternative D is equivalent to cancellation of a sale scheduled for a specific period in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007.* The OCS lease sales in the Central Gulf are scheduled on an annual basis. By canceling a proposed Central Gulf sale, the opportunity is postponed or foregone for development of the estimated 0.276-0.654 billion barrels of oil (BBO) and 1.590-3.300 trillion cubic feet (tcf) of gas.

Effects of the Alternative

Under Alternative D, the U.S. Dept. of the Interior cancels a planned Central Gulf of Mexico sale. Therefore, the oil expected from a sale would remain undiscovered and undeveloped. The environmental effects of Alternative A (proposed action) also would not occur. Other sources of energy would need to substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant environmental impacts of their own.

This section briefly discusses the most likely alternative sources, the quantities expected to be needed, and the environmental impacts associated with the alternatives. The discussion is based on material from the following MMS publications: *Proposed Final Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002, Decision Document* (USDOI, MMS, 1996a); *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002, Final Environmental Impact Statement* (USDOI, MMS, 1996b); and *Energy Alternatives and the Environment* (USDOI, MMS, 2001f). These sources are incorporated into this document by reference.

Most Important Substitutes for Production Lost Through No Lease Sale

Energy Alternatives and the Environment discusses a long list of potential alternatives to natural gas and oil. However, most substitutes for the natural gas and oil from the sale will come from four sources:

- additional imports;
- conservation;
- additional domestic production; and
- fuel switching.

Additional domestic production and imports will augment supply, while conservation and switching to alternative fuels shift demand downward. The table below shows the percentage and range of quantities expected to be needed to substitute for the lost natural gas and oil production. The quantities for conservation and fuel switching are in equivalent energy units.

Substitutes for Natural Gas and Oil Lost Because of No Lease Sale

Source	Percent of Lost Oil Production	Range of Oil Quantity (MMbbl)	Percent of Lost Gas Production	Range of Gas Quantity (Bcf)
Additional Imports	88%	134-385	12%	184-527
Conservation	5%	8-22	14%	214-615
Additional Domestic Production	4%	6-18	41%	627-1,800
Fuel Switching	3%	5-13	33%	505-1,449
Total Production Lost through No Sale	100%	153-438	100%	1,530-4,391

Environmental Impacts from the Most Important Substitutes

Additional Imports: Significant environmental impacts from an increase in oil imports include the following:

- generation of greenhouse gases and air pollutants from both transport and dockside activities (emissions of NO_x, SO_x, and VOC's have an impact on acid rain, tropospheric ozone formation, and stratospheric ozone depletion);
- degradation of water quality from oil spills related to accidental discharges or tanker casualties;
- oil-spill contact with flora, fauna, or recreational and scenic land and water areas; and
- increasing public concern about increasing imports of foreign oil and the potential for unauthorized interdiction or terrorist attacks on oil tankers..

Imported oil may also impose negative environmental impacts in producing countries and in countries along trade routes. Additional imports of natural gas would require construction of new pipelines from the most likely sources—Canada and Mexico. Pipeline construction can disrupt wildlife habitat, lead to increased erosion, and add to the siltation of streams and rivers.

Conservation: Conservation is composed of two major components:

- substituting energy-saving technology, often embodied in new capital equipment, for energy resources (e.g., adding to home insulation); and
- consuming less of an energy-using service (e.g., turning down the thermostat in an office during the winter)

Consuming less of an energy service is positive from an environmental perspective. Substituting energy-saving technology will tend to result in positive net gains to the environment. The amount of gain will depend on the extent of negative impacts from capital equipment fabrication.

Additional Domestic Production: Onshore oil and gas production has notable negative impacts on surface water, groundwater, and wildlife. It can also cause negative impacts on soils, air pollution, vegetation, noise, and odor. Offshore oil and gas production imposes the risk of oil spills affecting water quality, localized degradation of air quality, potential impacts on coastal wetlands dependent wildlife, and shoreline erosion from additional supply boat traffic. Offshore activities may also have negative impacts on social, cultural, and economic measures such as recreation.

Fuel Switching: The most likely substitutes for natural gas are oil, which will further increase imports, and coal for use in electricity generation. Coal mining causes severe damage to land and wildlife habitat. It also is a major contributor to water quality deterioration through acid drainage and siltation. Alternative transportation fuels may constitute part of the oil substitution mix. The mix depends on future technical and economic advances. No single alternative fuel appears to have an advantage at this time. Every fuel alternative imposes its own environmental effects.

Other Substitutes

Government could also impose other substitutes for natural gas and oil. The most likely sectors to target would be transportation, electricity generation, or various chemical processes. *Energy Alternatives and the Environment* discusses many of the alternatives at a level of detail impossible here.

Summary and Conclusion

Canceling a sale would eliminate the effects described for Alternative A (Chapter 4.2.1). Other sources of energy would substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant environmental impacts of their own.

4.3. Environmental Impacts of the Proposed Western Gulf Sales and Alternatives

4.3.1. Alternative A — The Proposed Actions

The proposed actions are proposed Western Gulf Lease Sales 187, 192, 196, and 200. The sales are scheduled to be held annually in August 2003 through 2006. Each sale will offer for lease all unleased blocks in the Western Planning Area (WPA). It is estimated that each proposed sale could result in the discovery and production of 0.136-0.262 billion barrels of oil (BBO) and 0.810-1.440 trillion cubic feet (tcf) of gas during the period 2003-2042. A description of the proposed actions is included in Chapter 2.4. Alternatives to the proposed actions and mitigating measures are also described in Chapter 2.4.

The analyses of the potential impacts are based on a scenario for a typical proposed action. These scenarios provide assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenarios and major impact-producing factors from routine activities associated with a proposed action is included in Chapters 4.1 and 4.2. The three proposed mitigating measures (Topographic Features, Military Areas, and Naval Mine Warfare Areas Stipulations) are considered part of the proposed action(s) for analysis purposes.

The scenario and analysis of potential impacts of oil spills and other accidental events are discussed in Chapter 4.4. The Gulfwide OCS Program and cumulative scenarios are discussed in Chapters 4.1, 4.2, and 4.3. The cumulative impact analysis is presented in Chapter 4.5.

4.3.1.1. Impacts on Sensitive Coastal Environments

Impacts to the general vegetation and physical aspects of coastal environments by activities resulting from a proposed action in the WPA are considered in Chapters 4.3.1.1.1, 4.3.1.1.2, and 4.3.1.1.3.

Potential impacts to barrier islands seaward of the barrier-dune system are considered in the coastal barrier beaches and associated dunes analysis. Potential impacts to barrier islands landward of the barrier-dune system are considered in the wetlands analysis. Impacts to animals that use these environments, the recreational value of beaches, and archaeological resources found there are described in impact analysis sections for those specific resources.

The major, nonaccidental, impact-producing factors associated with a proposed action that could affect these environments include navigational traffic, maintenance dredging of navigational canals, and construction and expansions of navigational canals, port facilities, processing facilities, pipelines, and pipeline-support facilities. The MMS has no direct regulatory authority over potential impact-producing factors or mitigation activities that may occur or be needed in the States' coastal zones.

4.3.1.1.1. Coastal Barrier Beaches and Associated Dunes

This section considers impacts from a proposed action in the WPA to the physical shape and structure of barrier beaches and associated dunes. The major impact-producing factors associated with a proposed action that could affect barrier beaches and dunes include pipeline emplacements, navigation channel use and dredging, and use and construction of support infrastructure in these coastal areas.

Pipeline landfall sites on barrier islands could accelerate beach erosion and island breaching. Studies have shown that little to no impact to barrier beaches results from pipeline landfalls employing modern installation techniques, such as directional boring (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988).

Navigation channels through the sandbars at the mouths of flowing channels generally capture and remove sediments from the longshore sediment drift, if the cross-sectional area of the channel is too large for natural tidal and storm exchanges to keep swept clear. Periodic maintenance dredging is expected in existing OCS-related navigation channels through barrier passes and associated bars. Jetties designed to reduce channel shoaling and maintenance dredging of bar channels affect the stability of barrier beaches and dunes if those jetties or bar channels serve as sediment sinks that intercept sediment in longshore drift. Materials from maintenance dredging of bar and pass channels are typically discharged to nearby, ocean dump sites in the Gulf (Chapter 4.1.3.2.1.). This dredging usually removes sediment from the littoral sediment drift or routes it around the beach immediately downdrift of the involved channel. Placement of dredged material in shallow coastal waters forms sandbars that can impair coastal navigation.

Adverse impacts of navigational channels can be mitigated by discharging dredged materials either onto barrier beaches or strategically into longshore sediment currents, downdrift of maintained channels. Adverse impacts of sediment sinks created by jetties can be further mitigated by reducing the jetty length to the minimum needed and by filling the updrift side of the jetty with appropriate sediment. Sediment traps that are created by dredging artificially large bar channels may be mitigated by reassessing the navigational needs of the port and reducing the depth of the channel, if the present depth is not needed. Mitigating adverse impacts should be addressed in accordance with requirements set forth by the appropriate Federal and State permitting agencies.

No onshore infrastructure used to support OCS operations has been constructed recently on barrier beaches in Texas or Louisiana, except for pipeline landfalls. The use of some existing facilities in support of a proposed action and subsequent lease sales in the WPA may extend the useful lives of those facilities. During that extended life, erosion-control structures may be installed to protect a facility. Although these measures may initially protect the facility as intended, such structures may accelerate erosion elsewhere in the vicinity. They may also cause the accumulation of sediments updrift of the structures, sediments that might have alleviated erosion downdrift of the structure. These induced erosion impacts would be most damaging locally. In Louisiana where the sediment supply is critically low, these impacts may be distributed much more broadly. These impacts will last as long as the interruption of the sediment drift continues, which may continue after the structure is removed if the hydrodynamics of the area are permanently modified.

Expansions of existing facilities located on barrier beaches or in associated dunes would cause loss and disturbance of additional habitat.

Abandoned facility sites must be cleared in accordance with Federal, State, and local governmental and landowner requirements. All materials and structures that would impair or divert sediment drift among the dunes and on the beach must be removed.

Proposed Action Analysis

No new coastal infrastructure is projected to be built on barrier beaches and dunes. Zero to one pipeline landfalls are projected as a result of a proposed action in the WPA. Should one be constructed, it will most likely be in coastal Subarea TX-2, where the large majority of the pipelines from the WPA come ashore. Such a landfall may occur in the immediate vicinity of a barrier beach and associated dunes. Wherever a landfall occurs, permitting processes encourage the use of directional boring technology to greatly reduce and perhaps eliminate impacts to barrier beaches or dunes.

No new navigation channels are expected to be dredged as a result of a proposed action or OCS Program activities in the WPA. No deepening of existing navigation channels is expected as a result of a proposed action. Current channel depths in Texas are adequate to accommodate activities expected to result from a proposed action.

The average contribution of a proposed action to vessel traffic in navigation canals is expected to be small (less than 1%). Correspondingly, the percentage of beach erosion caused by interrupted littoral sediment drift by channels and their jetties as a result of a proposed action would be very low.

Summary and Conclusion

The 0-1 pipeline landfalls projected in support of a proposed action are not expected to cause significant impacts to barrier beaches because of the use of nonintrusive installation methods. Existing facilities originally built inland may, through natural erosion and shoreline recession, be located in the barrier beach and dune zone and contribute to erosion there. A proposed action may contribute to the continued use of such facilities.

Maintenance dredging of barrier inlets and bar channels is expected to occur, which combined with channel jetties, generally causes minor and very localized impacts on adjacent barrier beaches downdrift of the channel due to sediment deprivation. Based on use, a proposed action would account for a very small percentage of these impacts, which would occur whether a proposed action is implemented or not.

In conclusion, a proposed action is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. A proposed action may extend the life and presence of facilities in eroding areas, which can accelerate erosion there. Strategic placement of dredged material from channel maintenance, channel deepening, and related actions can mitigate adverse impacts upon those localized areas.

4.3.1.1.2. Wetlands

The Texas Gulf Coast is comprised of a broad range of saline, brackish, intermediate, and fresh marsh wetlands, including wet prairies, forested wetlands, barrier islands, mud flats, estuarine bays, bayous, and riparian wooded areas. Saline and brackish marshes are most widely distributed south of the Galveston Bay area, while intermediate marshes are the most extensive marsh type east of Galveston Bay. The most extensive wetlands along the Texas coast are located in the Strandplain-Chenier Plain System that runs from eastern Chambers County, Texas, through Vermilion Parish, Louisiana.

The OCS oil and gas activities that could potentially impact these wetland types and their associated habitats include pipeline emplacement (construction and maintenance), new and maintenance dredging of navigation channels and canals, vessel usage of navigation channels, and construction and maintenance of inshore facilities. Other potential impacts that are indirectly associated with OCS oil and gas activities are wake erosion resulting from navigation traffic and additional onshore development encouraged by increased capacities of navigation channels.

Pipelines

Most disturbances associated with pipeline construction (Chapter 4.1.2.1.7) are expected to result in temporary adverse impacts that are expected to be partially corrected after approximately 6 years (Tabberer et al., 1985; Wicker et al., 1989). Pipelines can be emplaced using a variety of techniques, which, with incorporation of mitigation measures, can influence the extent of impact to the environment. The two major emplacement techniques used historically in wetland environments are the push-pull ditch and the flotation canal methods.

A WPA proposed action will potentially contribute to approximately 1 percent of overall impacts to wetlands and associated coastal habitats by OCS-related coastal pipeline implementation and required maintenance of those installations. As previously discussed in Chapter 4.1.1.3.8.1, petroleum reservoirs in deepwater areas might require their own pipeline landfall. The projected numbers of coastal pipeline installations and the projected lengths of coastal pipelines related to a proposed action are presented Table 4-13.

A major concern associated with pipeline construction is disturbance caused by backfilling. Pipeline canals are backfilled with the materials originally dredged while digging the canal. The major factors determining the success of backfilling as a means of restoration are the depth of the canal, soil type, canal dimensions, locale, dredge operator skill, and permitting conditions (Turner et al., 1994). Plugging the canal has no apparent effect on water depth or vegetation cover, with one exception—submerged aquatic vegetation was more frequently observed behind backfilled canals with plugs than in backfilled canals without plugs. Canal length and percentage of backfill returned has the greatest effect on the recovery of vegetation cover (Turner et al., 1994). While investigating backfilling canals as a wetland restoration technique in coastal Louisiana, Turner et al. (1994) discovered that canals backfilled as mitigation for dredging done at another location are typically more shallow if they are older or in soils lower in organic matter. Vegetation recovery increases with an increased canal length and percentage of material returned. In areas where soils have high organic content, as in deltaic plains or the Chenier Plain, backfilling does not usually fill a canal completely.

The extent of impact from the push-pull ditch technique also may be influenced by whether the ditch is backfilled and/or dammed. Dredge deposits associated with push-pull ditches are considerably less than those with flotation canals, but both have potential for impact related to the configuration of the deposits of dredge materials. For both flotation and push-pull canals, a double-ditching technique can be used to ensure that the top soil is placed on top when the site is backfilled. This expedites revegetation and lessens the potential for detrimental impacts such as land loss due to erosion along the unvegetated right-of-way.

The real loss of wetland habitat is difficult to determine because it depends on the pipeline emplacement technique used, amount of backfilling, time of year, and duration of construction. After pipelines are constructed and backfilled in Texas wetlands, a shallow channel is expected to remain where the canal passes through the wetland; after backfilling in the coastal subareas of Louisiana, some open-water areas may remain. Approximately six years after backfilling has occurred, productivity of vegetation in areas directly over the pipeline is expected to be reduced. It is estimated that wetland habitat could be reduced by as much as 25 percent in Texas. For the same period of time (approximately six years), productivity of vegetation in a 2- to 3-m-wide strip of wetland on either side of the pipeline is expected to be reduced as much as 11 percent in Texas. A substantial number of new OCS pipelines that cross the offshore Federal/State boundary do not come ashore directly but rather link up to previously existing pipelines that already make landfall; hence, no landfall or onshore pipeline construction will result (Chapter 4.1.2.1.7).

Secondary impacts of pipeline channels can be even more damaging to coastal wetlands and associated habitats than the primary impacts (Tabberer et al., 1985). Secondary impacts include expansion of tidal influence, saltwater intrusion, hydrodynamic alteration, erosion, sediment export, flank subsidence, and habitat conversion. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of these secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements. The number of OCS-related mitigative structures around the Gulf is unknown.

Frequently, the lack of maintenance of structures used to mitigate adverse impacts of pipeline construction allows the structures to deteriorate and eventually fail. Consequently, the indirect and adverse impacts upon wetlands that the structures were designed to prevent or mitigate could resume and possibly proceed at an accelerated rate. No known effort has been made to document the frequency or extent of these failures or the severity of the resulting impacts.

The widening of pipeline canals over time is one of the more obvious secondary impacts. Craig et al. (1980) studied a series of canals in Louisiana and determined that the canals widened at rates of 2-14 percent per year. Dead-end canals with little traffic or significant flow were shown to widen at rates within this range. Based on the 1980 study due to their shallow nature, OCS-related pipeline canals are expected to widen at an average rate of about 4 percent per year.

The MMS is presently conducting a study in conjunction with USGS Biological Resources Division to investigate coastal wetland impacts from the widening of OCS-related pipeline canals and the effectiveness of mitigation. For a proposed action in the WPA, 0-1 pipeline landfalls are projected. Up to 40 km of onshore pipeline are projected to be constructed in coastal Texas and western coastal Louisiana in support of a proposed action in the WPA. In Subareas TX-1 and TX-2, about 25 percent of each pipeline is assumed to occur in wetlands. Associated canals through wetlands will probably widen by 4 percent each year.

The MMS is presently conducting a study in conjunction with USGS-BRD to investigate coastal wetland impacts from the widening of OCS-related canals rates and the effectiveness of mitigation. At present, there is no known study addressing the effectiveness or longevity of canal-related mitigation. Also, MMS is currently identifying and mapping onshore OCS-related pipelines in the coastal regions around the Gulf including those in wetland habitats in Kenedy, Aransas, Calhoun, Matagorda, Brazoria, Galveston, and Orange Counties of Texas. With the OCS pipelines identified, this study will provide basic information for environmental impact assessments and for mitigation development by MMS and other Federal agencies.

Dredging

No new navigational channels are expected to be dredged as a result of a proposed action in the WPA. An increase in OCS deepwater activities, which require larger service vessels for efficient operations, is expected. This may shift some deepwater support activities to shore bases associated with deeper channels. Some of the ports that have navigation channels that can presently accommodate deeper-draft vessels may expand port facilities to accommodate these deeper-draft vessels, e.g., Port of Galveston.

Dredging and dredged-material disposal can be detrimental to coastal wetlands and associated fish and wildlife that use these areas for nursery grounds, protection, etc. Periodic maintenance dredging of navigation channels results in additional deposits material on existing dredged-material disposal banks; the effects of dredged-material disposal banks on wetland drainage is expected to continue unchanged, although there may be some localized and minor aggravation of existing problems. Typically, some material intended for placement on a dredged-material disposal bank is placed in adjacent wetlands or shallow water. Wetland loss due to dredge material deposition is expected to be offset by wetland creation as adjacent margins of shallow water are filled. In both cases, areas impacted are considered small. Maintenance dredging will also temporarily increase turbidity levels in the vicinity of the dredging and disposal of materials, which can impact emergent wetlands, seagrass communities and associated habitats. Two different methods are generally used to dredge and transport sediments from channels to open-water sites: (1) hydraulic cutterhead suction dredge transfers sediments via a connecting pipelines; and (2) clamshell bucket dredge transfers sediments via towed bottom-release scows. Each method produces a distinctly different deposit. Hydraulic dredging creates a slurry of sediment and water, which is pumped through a pipeline to the dredged material disposal site. Coarser sediment settles to the bottom where it spreads outward under the force of gravity; finer sediments may remain in suspension longer. The clamshell dredge scoops sediments relatively intact into scows, which are then towed to the designated area. The dredged sediments are released into the area specified for disposal. This method usually produces positive relief features in the placement area.

Access canals, as well as pipeline canals, are commonly bordered by levees created using dredged material (Rozas, 1992). Placement of this material alongside canals converts marsh to upland, an environment unavailable to aquatic organisms except during extreme tides. Dredge material can also form a barrier causing ponding behind levees and limiting circulation between canal waters and marshes to infrequent, high-water events (Swenson and Turner 1987; Cox et al., 1997). This and similar disruptions to marsh hydrology are believed to change coastal habitat structure as well as accelerate marsh erosion and conversion to open water (Kuhn et al., 1999; Turner et al., 1994; Rozas, 1992; Turner and Cahoon, 1987). The MMS/USGS-BRD study previously mentioned above (pipelines) will attempt to quantify the impacts of dredged-material deposition as well as other canal-related impacts, which should provide insights for identifying past and future impacts.

Executive Order 11990 requires that material from maintenance dredging be considered for use as a sediment supplement in deteriorating wetland areas to enhance and increase wetland acreage, where appropriate. Disposal of dredged material for marsh enhancement has been done only on a limited basis (Chapter 4.1.2.1). Given the "mission statement" of the COE, which requires it to take environmental impacts into consideration during its decisionmaking processes, increased emphasis has been placed on the use of dredged material for marsh creation. For a proposed action, increased use of dredged material to enhance wetland habitats is encouraged as mitigation.

Vessel Traffic

Vessel traffic that may support a proposed action is discussed in Chapter 4.1.1.3.8.4. Most navigation channels projected to be used in support a WPA proposed action (Chapter 4.1.2.1.10) are shallow and are currently used by vessels that support the OCS Program (Table 3-30). Waves generated by boats, ships, barges, and other vessels erode unprotected shorelines and accelerate erosion in areas already affected by the natural erosion process as evident along the Texas coast where heavy traffic using the Gulf Intracoastal Waterway (GIWW) has accelerated erosion of existing salt marsh habitat (Cox et al. 1997).

According to Johnson and Gosselink (1982), canals that have high navigation usage in coastal Louisiana widen about 2.58 m/yr, compared with 0.95 m/yr for little used canals. The OCS-related navigation canals are assumed to generally widen at an average rate of 1.5 m/yr. Approximately 2,020 km of OCS-related navigation canals, bayous, and rivers are found in the coastal regions around the Gulf, exclusive of channels through large bays, sounds, and lagoons. About 440 km of these channels are found around the WPA; another 810 km is found in Subarea LA-1.

Specific to navigation channels are the effects from saltwater intrusion (Gosselink et al., 1979; Wang 1987). Wang (1987) developed a model demonstrating that under certain environmental conditions, salt water penetrates farther inland in deep navigation channels than in shallower channels, suggesting that navigation channels act as "salt pumps." The Calcasieu Ship Channel is a good example of how saltwater intrusion, as a consequence of channelization, results in significant habitat transition from freshwater to brackish and ultimately to salt or open-water systems. Another example is the construction of the Mississippi River Gulf Outlet that led to the transition of many of the cypress swamps east of the Mississippi River below New Orleans to open water or areas largely composed of marsh vegetation (*Spartina)* with old, dead cypress tree trunks.

The GIWW, completed in 1949, carries barges of crude oil, petroleum, bulk cargoes, and miscellaneous items along a 12-ft deep channel protected from the storms, waves, and winds of the Gulf of Mexico. In 1994, vessels navigating the GIWW between the Harvey Canal in New Orleans and the Sabine River in Texas carried more than 67 million tons of goods, including 36.1 million tons of petroleum and petroleum products and 12.8 million tons of chemicals.

Service-vessel traffic is a necessary component of the OCS activities. An increase in the number of vessels creating wakes could potentially increase impact to coastal habitats including wetlands.

Disposal of OCS-Related Wastes

Produced sands, oil-based or synthetic-based drilling muds and cuttings, and some fluids from well treatment, workover, and completion activities will be transported to shore for disposal. Sufficient disposal capacity is assumed to be available in support of a proposed action (Chapter 4.1.2.1.11). Discharging OCS-related produced water into inshore waters has been discontinued; all OCS-produced waters are discharged into offshore Gulf waters in accordance with NPDES permits or are transported to shore for injection. Produced waters are not expected to affect coastal wetlands (Chapter 4.1.2.1.9).

Because of wetland-protection regulations, no new waste disposal site will be developed in wetlands. Some seepage from waste sites into adjacent wetland areas may occur and result in damage to wetland vegetation. State requirements are expected to be enforced to prevent and correct such occurrences.

Onshore Facilities

Various kinds of onshore facilities service OCS development. These facilities are described in Chapter 4.1.2.1 and Table 4-8. All projected new facilities are attributed to the OCS Program, with an appropriate proportion attributed to a proposed action; none will be in wetland areas. State and Federal permitting agencies discouraged the placement of new facilities or expansion of existing facilities in wetlands. Any impacts upon wetlands from existing facilities are expected to be mitigated.

Proposed Action Analysis

Estimates of wetland acreage in the 19 coastal counties in 1979 range from 611,760 ac of fresh, brackish, and salt marshes (Texas Parks and Wildlife Dept., 1988) to approximately 1.8 million acres of salt, brackish, fresh, forest, and scrub-shrub wetlands (Field et al., 1991). The Texas Parks and Wildlife Dept. estimates that 35 percent of the State's coastal marshes were lost between 1950 and 1979 (Texas Parks and Wildlife Dept., 1988; Texas General Land Office, 2001). The total loss of marshes in the river deltas since the 1950's amounts to about 21,000 ac, or 29 percent, of the river-delta marsh (White and Calnan, 1990). In the Galveston Bay system, from the 1950's to 1989, there was a net loss of 33,400 ac, which amounts to 19 percent of the wetlands that existed in the 1950's (White et al., 1993). This rate of loss has declined over time, from about 1,000 ac per year between 1953 and 1979 to about 700 ac per year between 1979 and 1989.

Direct causes of wetland loss along the Texas coast potentially associated with a proposed action are

- dredging and stream channelization for navigation channels and pipeline canals;
- filling by dredged material and other solid waste disposal;
- roads and highways;
- industrial development and infrastructure improvement; and
- accidental discharge of pollutants into wetlands.

Indirect causes of wetland loss may be attributed to

- subsidence due to lack of natural sediment replenishment of the deltaic/wetland system caused by channel and river controls;
- sediment diversion by dams, deep channels, and other structures;
- hydrologic alterations by canals, dredge banks, roads, and other structures; and
- subsidence due to extraction of groundwater, oil, gas, sulphur, and other minerals.

Table 4-13 shows the distribution of projected new, OCS-related pipeline landfalls and inland pipeline lengths for a proposed action. On average, 12 percent of traffic using OCS-related navigation channels is related to the OCS Program; therefore, impacts related to a proposed action should remain minimal. Since the number of OCS-related mitigative structures is unknown, impacts creditable to a proposed action cannot be calculated. Impacts associated with mitigation structures and canals are altered hydrology and flank subsidence, for which methods of projecting rates of occurrence and extent of influence have not yet been developed. An MMS study of canal-impact issues began during the summer of 1997; a final report is expected in the Fall of 2002. These projections will be updated for subsequent EIS's using data presently being developed.

Summary and Conclusion

A proposed action is projected to contribute to the construction of 1 new onshore pipeline in the WPA; therefore, the projected impact to wetlands from pipeline emplacement is expected to be minimal. As a secondary impact, some wetlands could potentially be converted to open water by continued widening of existing pipeline and navigational canals.

Maintenance dredging of navigation channels related to a proposed action are expected to occur with minimal impacts. Alternative dredged-material disposal methods can be used to enhance and create coastal wetlands.

Deepening an existing channel to accommodate larger service vessels may occur within the previously described environment(s) and could generate the creation of a small area of wetland that would be attributable to a proposed action.

In conclusion, adverse impacts of installation, maintenance, continued existence, and the failure of mitigation structures of pipeline and especially navigation canals are considered the most significant continuing OCS-related and proposed action-related impacts to wetlands. Although the OCS-related impacts discussed for a proposed action are regarded as considerable locally, where OCS-related canals and channels pass through wetlands, proposed action-related impacts are seen as less substantial because of their low representative percentages of the OCS Program. Their broad and diffuse distribution over coastal Texas makes it difficult to distinguish these impacts from other ongoing, OCS-related impacts to wetlands.

4.3.1.1.3. Seagrass Communities

Seagrasses in the WPA are widely scattered beds in shallow, high-salinity coastal lagoons and bays. The most extensive seagrass bed communities are found in both the Upper and Lower Laguna Madre along the Texas coast, as well as Baffin Bay. In the Texas Laguna Madre, seagrass meadows are the most common submerged habitat type. Although permanent meadows of perennial species occur in nearly all bay systems along the Texas Gulf Coast, the majority (79%) of the State's seagrass cover is found in the Laguna Madre (Pulich, 1998), with seagrasses currently covering about 243 km^2 in the upper portion of the Laguna Madre (Quammen and Onuf, 1993). Seagrass communities are largely excluded from bays north of Pass Cavallo where rainfall and inflows are high and salinity averages less than 20 ppt, as well as from the upper, fresher portions of most estuaries. Seagrass communities in the Laguna Madre constitute a unique resource that cannot be duplicated elsewhere on the Texas coast (Withers, 2001). Lower-salinity, submerged beds of aquatic vegetation are found inland and discontinuously in coastal lakes, rivers, and the most inland portions of some coastal bays.

The OCS oil and gas activities that could adversely affect seagrass communities include pipeline construction and canals, dredging of new navigation channels, maintenance dredging and vessel usage of navigation channels (propeller scars, etc.), construction and maintenance of inshore facilities, oil spills, and spill-response and cleanup activities. The potential impacts of oil spills and spill-response and cleanup activities are discussed in Chapter 4.4.3.1.3.

Pipelines

The installation of 0-1 pipeline landfalls is projected as a result of a WPA proposed action (Chapter 4.1.2.1.8). Pipeline construction methods and disturbances are discussed in Chapters 4.1.1.3.8.1 and 4.1.2.1.8. Jetting displaces sediments with denser sediments falling out of suspension quickly; the finer sediments that decrease water clarity remain in suspension longer. Reduced water clarity can decrease plant density in seagrass beds, which in turn can further increase turbidity as the root, thatch, and leaf coverage decreases (Wolfe et al., 1988). The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow or community extent and productivity. As in maintenance dredging activities discussed below, activities from pipeline emplacement will reduce light, which is linked to reductions of both seagrass cover and productivity (Orth and Moore, 1983; Kenworthy and Haunert, 1991; Dunton, 1994; Czerny and Dunton, 1995).

The COE and State agencies take possible impacts to submerged vegetation into consideration during their review of pipeline permits. The permits for constructing pipelines require that turbidity impacts be mitigated through the use of turbidity screens and other turbidity reduction or confinement equipment. The permits also require surveys to locate seagrass beds of submerged vegetation, turbidity monitoring with reporting to the COE and State agencies, and immediate action taken to correct turbidity problems.

Maintenance Dredging

No new navigation channels are expected to be dredged as a result of a proposed action or OCS Program activities in the WPA. The ports that support these service bases presently accommodate deeper-draft vessels that support the OCS Program. The service bases are discussed in Chapter 4.1.2.1.1.

Impacts to seagrass and associated habitat can occur from periodic maintenance dredging of navigation channels. Changes in species composition are mostly the result of natural processes (i.e., succession) but were set in motion by moderation of salinity resulting from dredging of the Gulf Intracoastal Waterway (GIWW) and Mansfield Pass. However, decreases in cover and biomass have also been occurring. In the upper Laguna Madre, shoalgrass cover decreased by 3.8 percent (9.4 km^2 [3.6 mi^2]) between 1988 and 1994, and shoalgrass biomass at depths >1.4 m (4.6 ft) decreased by 60 percent (Onuf, 1996b). For the most part, these decreases have been attributed to brown tide occurrences that started in 1990 and continues in some parts of the system today. Changes in species composition due to succession have been most pronounced in the lower Laguna Madre, but a more troubling change is increased bare area. Overall, bare area has increased to 190 km^2 (73 mi^2), up 280 percent between 1965 and 1988 (Quammen and Onuf, 1993). Turbidity caused by maintenance dredging has been implicated in the decline of shoalgrass and increased bare areas in the lower Laguna Madre (Onuf, 1994). Light attenuation is responsible for most landscape-level losses, with scarring by vessel traffic also a concern. The amount of light reaching the bottom of a seagrass bed is the crucial factor determining seagrass meadow extent and productivity. Reduced light has been linked to reductions of both seagrass cover and productivity (Orth and Moore, 1983; Kenworthy and Haunert, 1991; Dunton, 1994; Czerny and Dunton, 1995). Dredging has been determined to be one of the major causes of light reduction that results in changes in seagrass cover, composition, and biomass. Changes in species composition resulting from dredging activities may affect resource availability for some fish and waterfowl that use seagrass habitat as nursery grounds.

Deepwater activities are anticipated to increase, requiring use of larger service vessels for efficient operations, which may shift greater emphasis to shore bases associated with deeper channels. Maintenance dredging schedules vary from yearly to rarely and will continue indefinitely into the future.

Vessel Traffic

Navigation traffic that may support a proposed action is discussed in Chapter 4.1.2.1.1.0. Most navigation channels projected to be used for a WPA proposed action are shallow and are currently used by vessels that support the OCS Program (Table 3-30). For example, the GIWW is dredged to an average depth of 4 m, but varies in depth between ports. Propwashing of shallow navigation channels by vessel traffic dredges up and resuspends sediments, increasing the turbidity of nearby coastal waters.

Vessels that vary their inland route from established navigation channels can directly scar beds of submerged vegetation with their props, keels (or flat bottoms), and anchors.

Proposed Action Analysis

Pipelines

Gas production and the great majority of oil production from a WPA proposed action is expected to be commingled in pipelines with other OCS production at sea before going ashore. Seagrass communities are not abundant in the Federal OCS waters, where most of the pipeline supporting a proposed action would be installed. The installation of 0-1 pipeline landfalls is projected as a result of a proposed action in the WPA (Chapter 4.1.2.1.8) with a potential landfall likely to be in or around Galveston County.

Although the majority of materials dredged by jetting return to the water bottom within a few meters of the trench, lighter materials can be carried for several kilometers, depending upon the currents, weather, and density of the dredged materials. Hence, pipeline installation has the potential to bury nearby submerged vegetation; coat the leaves of plants farther away with lighter, light-blocking sediments; and temporarily elevate turbidity in these beds. Permit requirements of the COE and State agencies are expected to require the reduction of turbidity impacts to within tolerable limits for submerged aquatic vegetation. Therefore, significant direct impacts to submerged vegetation by pipeline installation are expected to be very small and short term if they occur.

Maintenance Dredging

Because much of the dredged material resulting from maintenance dredging will be placed on existing dredged material disposal sites or used for other mitigative projects, no significant adverse impacts are expected to occur to seagrass communities from maintenance dredging credited to a proposed action. By artificially keeping navigation channels open and with larger dimensions than the region hydrodynamics would, maintenance dredging maintains tidal and storms flushing potential of inland regions at maximum capacities as they relate to the described needs of the canal projects. Without maintenance dredging, these channels would naturally fill in, reducing the channels' cross-sectional areas and their capacities to flush or drain a region when under the influences of storms and tides.

Vessel Traffic

Most of the navigation channels to be used for a proposed action are shallow, therefore allowing for possible scarring impacts to associated seagrass and submerged vegetation. For that reason, propwashing related to a proposed action may substantially resuspend sediments in these areas. Navigational traffic using the GIWW along the Texas coast would resuspend sediments in numerous areas. A proposed action would represent a substantial percentage of existing traffic along the Texas coast. However, beds of submerged vegetation within the area of influence and other channels have already adjusted their configurations in response to turbidity generated there.

Many vessel captains will cut corners of channel intersections or navigate across open water where they may unexpectedly encounter shallow water where beds of submerged aquatic vegetation may occur. Propellers may damage a bed superficially by leaving a few narrow cuts. Damage may be as extensive as broadly plowed scars from the keel of a large boat accompanied by extensive propwashing; trampling by waders; and additional keel, prop, and propwash scars left by other vessels that assisted in freeing the first boat.

Depending upon the submerged plant species involved, scars about 0.25 m wide cut through the middle of beds would take 1-7 years to recover. Similar scars through sparser areas would take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area may never be corrected (Sargent et al., 1995).

Denser dredged materials fall out of suspension more quickly. Less dense sediments settle to the water bottom more slowly, which concentrates at the surface of the water bottom. These lighter bottom sediments are generally more resuspendable by storms than were the original surface sediments. Therefore, for a period of time after dredging occurs, water turbidity will be greater than usual in the vicinity of the dredging. With time, this reoccurring, increased turbidity will decrease to pre-project conditions, as the lighter materials are either dispersed to deeper water by currents, where they are less available for resuspension, or they are consolidated into or under denser sediments.

For estuarine species that thrive in salinities of about 0.5-25 ppt, this elevated turbidity may not pose a significant problem because they have adapted to turbid, estuarine conditions. For seagrass beds in higher salinities and even freshwater submerged aquatic vegetation that require clearer waters, significantly reduced water clarity or shading, as may be caused by an oil slick, for longer than about 4 days will decrease chlorophyll production. If such conditions continue for longer than about 2 weeks, plant density in the bed will begin to decrease. If plant density reduces significantly in turn, further increases in turbidity will occur as the root, thatch, and leaf coverage decline.

Such impacts can be mitigated in several ways. For cleaning up slicks resting over a submerged vegetation bed, wheeled or treaded vehicles should be prohibited. Cleanup methods using other vehicles that dig into the water bottom of the bed (e.g., boat anchors, boat bottoms, props, and booms that require water depths greater than that available over the bed) should be not be used. Vehicles and equipment that require minimum water depths of about 6-10 in should be used instead. Activities over grass beds should be closely monitored to avoid digging into the bed. Trampling or repeatedly walking over a path through the bed should be avoided.

Summary and Conclusion

Most seagrass communities located within a WPA proposed action are located behind the barrier islands, sparsely distributed in bays and estuaries along coastal Louisiana and Texas, including the Tamaulipas, Mexico Laguna Madre. Because of the location of most seagrass communities, inshore oil spills pose the greatest threat. The potential impacts from oil spills are discussed in Chapter 4.4.3.2.1.

Pipeline construction in coastal waters would temporarily elevate turbidity in nearby submerged vegetation beds, depending upon currents. If constructed, the pipeline landfall would temporarily elevate turbidity in submerged vegetation beds near the pipeline routes. The COE and State permit requirements are expected to require pipeline routes that avoid beds of high-salinity, submerged vegetation and to reduce turbidity impacts to within tolerable limits. Therefore, impacts to submerged vegetation by pipeline installation are projected to be very small and short term. As previously discussed in Chapter 4.1.2.1.5, petroleum reservoirs in deepwater areas could require their own pipeline landfall. Table 4-8 lists the projected number of additional OCS pipeline landfalls and their inshore lengths to be constructed during a WPA proposed action.

After bottom sediments are disturbed by pipeline installation, they will be generally more easily suspended by storms than before the disturbance. In estuaries, this increase is not projected to be a problem. Due to tidal flushing, this increased turbidity is projected to be below significant levels and to continue after storms for up to one month.

Beds of submerged vegetation within a channel's area of influence will have already adjusted to bed configurations in response to turbidity generated there. Very little, if any, damage would then occur as a result of typical channel traffic. Generally, propwash will not resuspend sediments in navigation channels beyond pre-project conditions.

Depending upon the submerged plant species involved, narrow scars in dense portions of the beds will take 1-7 years to recover. Scars through sparser areas will take 10 years or more to recover. The broader the scar, the longer the recovery period. Extensive damage to a broad area may never be corrected.

Maintenance dredging will not have a substantial impact on existing seagrass habitat given that no new channels are expected to be dredged as a result of a WPA proposed action.

4.3.1.2. Impacts on Sensitive Offshore Resources

4.3.1.2.1. Live Bottoms (Topographic Features)

The topographic features sustaining sensitive offshore habitats in the WPA are listed and described in Chapter 3.2.2.2. A Topographic Features Stipulation similar to the one described in Chapter 2.3.1.3.1 has been included in appropriate leases since 1973 and may, at the option of the Secretary, be made a part of appropriate leases resulting from this proposal. The impact analysis presented below for a proposed action in the WPA includes the proposed biological lease stipulation. As noted in Chapter 2.3.1.3.1, the stipulation establishes a No Activity Zone in which no bottom-disturbing activities would be allowed and areas around the No Activity Zones (in most cases) within which shunting of drill cuttings and drilling fluids to near the bottom would be required.

The potential impact-producing factors on topographic features of the Western Gulf are anchoring (Chapter 4.1.1.3.2.1), infrastructure emplacement (Chapters 4.1.1.3.1 and 4.1.1.3.2), drilling-effluent and produced-water discharges (Chapter 4.1.1.3.4), and infrastructure removal (Chapter 4.1.1.3.3). Impacts from oil spills and blowouts are discussed in Chapter 4.4.3.2.1. These disturbances have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features in the WPA.

The anchoring of pipeline lay barges, drilling rigs, or service vessels, as well as the emplacement of structures (e.g., pipelines, drilling rigs, or production platforms), results in mechanical disturbances of the benthic environment. Anchor damage has been shown to be the greatest threat to the biota of the offshore banks in the Gulf (Bright and Rezak, 1978; Rezak et al., 1985). Such anchoring damage, however, would be prevented within any given No Activity Zone by the observation of the Topographic Feature Stipulation.

Infrastructure emplacement and pipeline emplacement could resuspend sediments. The proposed stipulation would also prevent these activities from occurring in the No Activity Zone, thus preventing most of these resuspended sediments from reaching the biota of the banks.

Considering the relatively elevated amounts of drilling muds and cuttings discharged per well (10,542 bbl/exploratory well; 7,436 bbl/development well) (USEPA, 1993a and b), potential impacts on biological resources of topographic features should be expressly considered if drill sites occur in blocks directly adjacent to No Activity Zone boundaries (Topographic Features Stipulation). Potential impacts could be incurred through increased water-column turbidity, the smothering of sessile benthic invertebrates, and local accumulations of contaminants. The USEPA general NPDES permit sets special restrictions on discharge rates for muds and cuttings adjacent to topographic features bound by a No Activity Zone. Chapters 4.1.1.3.4 and 4.2.1.3.2 detail the NPDES permit's general restrictions and the impacts of drilling muds and cuttings on marine water quality and seafloor sediments. The levels and areal extent of discharged contaminants measured in the water column or sediments will be reduced from levels and extent measured in the past because current USEPA regulations and NPDES permits contain more restrictive limits (Chapter 4.2.1.3.2). The effects of past muds and cutting discharges are discussed in Chapter 4.2.1.3.2. A brief overview of the potential impacts on topographic features by drilling discharges follows.

Water-column turbidity and the smothering of sessile invertebrates of topographic features caused by drilling muds and cuttings are of little significance for two reasons. First, the Topographic Features Stipulation limits impact through the No Activity Zone shunting restrictions imposed within the 1-Mile Zone and 1,000-Meter Zone, as well as the USEPA general NPDES permit special restrictions on discharge rates in blocks adjacent to a No Activity Zone or sensitive areas, which necessitates photodocumentation by industry. Secondly, studies have shown the rapid dispersion of drilling fluid plumes in the OCS within a 1,000-m range of the discharge point and the resilience of sessile invertebrates exposed or smothered with an extreme range of concentrations of drilling muds (Kendall, 1983). For local accumulation of contaminants, assumptions are that trace-metal and petroleum contamination resulting from drilling muds and cuttings will occur mainly within a few hundred to a couple of thousand meters downcurrent from the discharge point and can be found up to 3,000 m downcurrent in shallow waters. Concentrations of contaminants decrease with an increasing distance from the drilling site. By examining sediments surrounding three gas production platforms (within a 100-m radius), Kennicutt et al. (1996) found low concentrations of petroleum and trace metal contaminants that would unlikely induce a biological response in benthic organisms. The highest trace metal concentrations originating from discharged drilling fluids found around platforms were strongly correlated with the presence of sand-size sediments. Shallow sites are subject to comparatively greater sediment removal and resuspension due to a high-energy environment. Contaminants from previous discharges under less restrictive conditions have been found to remain in sediments surrounding drill sites for as long as 10 years (Kennicutt et al., 1996). Toxic effects could be incurred by benthic organisms of topographic features found in the vicinity of a No Activity Zone boundary if the plume flow of an operation is consistently directed toward that boundary. Should effects occur, they would potentially persist for as long as 10 years following the onset of discharges.

Produced waters could also represent a significant potential source of impact to the biota of topographic features, considering produced water constitutes the largest single discharge during routine oil and gas operations. The USEPA general NPDES permit restrictions on the discharge of produced water help to limit the impacts on biological resources of topographic features. Past evaluation of the bioaccumulation of offshore produced-water discharges conducted by the Offshore Operators Committee (1997) assessed that metals discharged in produced water would, at worst, affect living organisms found in the immediate vicinity of the discharge, particularly those attached to the submerged portion of platforms. Naturally occurring radioactive material in produced water was not found to bioaccumulate in marine animals (2 species of molluscs and 5 species of fish). Because high-molecular, polycyclic aromatic hydrocarbons (PAH's) are usually in such dilute concentrations in produced water, they pose little threat to marine organisms and their constituents, and they were not anticipated to biomagnify in marine food webs. Monocyclic hydrocarbons and other miscellaneous organic chemicals are known to be moderately toxic, but they do not bioaccumulate to high concentrations in marine organisms and are not known to pose a risk to their consumers. A detailed description of the impacts of produced waters on water quality and seafloor sediments is presented in Chapter 4.2.1.3.

The impacts of structure removal on topographic features can include water turbidity, sediment deposition, and explosive shock-wave impacts. Both explosive and nonexplosive removal operations would disturb the seafloor by generating considerable turbidity. The deposition of resuspended sediments would occur much in the same manner as discussed for discharges of muds and cuttings, choking and causing mortality of sessile benthic organisms. Turbidity could both reduce light levels and obstruct filter-feeding mechanisms, leading to reduced productivity, susceptibility to infection, and mortality. The shock waves produced by the explosive structure removals could also harm associated biota. Corals and other sessile invertebrates have a supposedly high resistance to shock. O'Keeffe and Young (1984) described the impacts of underwater explosions on various forms of sea life using, for the most part, open-water explosions much larger than those used in typical structure removal operations. They found that sessile benthic organisms, such as barnacles and oysters, and many motile forms of life, such as shrimp and crabs, that do not possess swim bladders were remarkably resistant to shock waves generated by underwater explosions. Oysters located 8 m away from the detonation of 135-kg charges in open water incurred a 5-percent mortality rate. Crabs distanced 8 m away from the explosion of 14-kg charges in open water had a 90-percent mortality rate. Few crabs died when the charges were detonated 46 m away. O'Keeffe and Young (1984) also noted ". . . no damage to other invertebrates such as sea anemones, polychaete worms, isopods, and amphipods." Benthic organisms appear to be further protected from the impacts of subbottom explosive detonations by rapid attenuations of the underwater shock wave traversing the seabed away from the structure being removed. The shock-wave attenuation is significantly less in mud than in the water column, where it is known to impact fish up to 60 m away from a 11.3-kg charge blasted at a 100-m depth (Baxter et al., 1982). Theoretical predictions suggest that the shock waves of explosives set 5 m below the seabed, as required by MMS regulations, would further attenuate blast effects. Charges used in OCS structure removals are typically much smaller than some of those cited by O'Keeffe and Young. The *Programmatic Environmental Assessment for Structural Removal Activities* (USDOI, MMS, 1987) predicts low impacts on the sensitive offshore habitats from platform removal precisely because of the effectiveness of the proposed stipulation in preventing platform emplacement in the most sensitive areas of the topographic features of the Gulf of Mexico. Impacts on the biotic communities, other than those on or directly associated with the platform, would be conceivably limited by the relatively small size of individual charges (normally 22.7 kg or less per well piling and per conductor jacket) and by the fact that charges are detonated 5 m below the mudline and at least 0.9 seconds apart (timing needed to prevent shock waves from becoming additive). The stipulation discussed above would preclude platform installation in the No Activity Zone, thus preventing adverse effects from nearby removals.

Proposed Action Analysis

All of the 23 topographic features (shelf edge banks, low-relief banks, and south Texas banks) in the WPA are found in waters less than 200 m deep. They represent a small fraction of the Western Gulf area.

As noted above, the proposed Topographic Features Stipulation could prevent most of the potential impacts from oil and gas operations on the biota of topographic features, including direct contact during pipeline, rig, and platform emplacements and anchoring activities. Yet, operations outside the No Activity Zones could still affect topographic features through drilling effluent discharges and produced-water discharges, blowouts, and oil spills. Potential impacts from oil spills and blowouts are discussed in Chapter 4.4.3.2.1.

For a WPA proposed action, 63-104 exploration/delineation and development wells are projected for offshore Subareas W0-60 and W60-200. With the inclusion of the proposed Topographic Features Stipulation, no discharges would take place within the No Activity Zones. Drilling discharges would be shunted to within 10 m of the seafloor either within a radius of 1,000 m, 1 mi (1,609 m), 3 mi (4,828 m), or 4 mi (6,437 m) (depending on the topographic feature) around the No Activity Zone. This procedure would essentially prevent the threat of large amounts of drilling effluents reaching the biota of a given topographic feature. It has been estimated, however, that drilling effluents and produced waters could reach and impact topographic features 5-10 times during the life of this proposal. The severity of such impacts would probably be primarily sublethal such that there may be a disruption or impairment of a few elements at the regional or local scale but no interference to the general system performance. Recovery to pre-impact conditions should take place within 2 years.

For a WPA proposed action, 7-10 production structures are projected in offshore Subareas W0-60 and W60-200. Between 4 and 6 structure removals using explosives are projected for the W0-60 subarea and 1 is projected in Subarea W60-200. The explosive removals of platforms should not impact the biota of topographic features because the Topographic Features Stipulation restricts the emplacement of platforms to locations most certainly farther than 100 m from No Activity Zone boundaries. This emplacement would prevent shock-wave impacts and resuspended sediments from reaching the biota of topographic features.

Summary and Conclusion

The proposed Topographic Features Stipulation could prevent most of the potential impacts on live-bottom communities from bottom-disturbing activities (structure removal and emplacement) and operational discharges. Recovery from impact incidences of operational discharges would take place within 10 years.

Effects of the Proposed Action Without the Proposed Stipulation

The topographic features and associated coral reef biota of the Western Gulf could be adversely impacted by oil and gas activities resulting from a proposed action should they be unrestricted by the absence of the proposed Topographic Features Stipulation. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected Western Gulf topographic features.

The No Activity Zone would probably be the area of the topographic features most susceptible to adverse impacts if oil and gas activities are unrestricted by the Topographic Feature Stipulation and not followed up by mitigating measures. These impacting activities could include vessel anchoring and infrastructure emplacement, discharges of drilling muds and cuttings, and ultimately the explosive removal of structures. All the above-listed activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone. In most cases, recovery from disturbances would take 10 years or more. Long-lasting and possibly irreversible change would be caused mainly by vessel anchoring and structure emplacement (pipelines, drill rigs, and platforms). Indeed, such activities would physically and mechanically alter benthic substrates and their associated biota over areas possibly ranging from tens to thousands of square meters per impact. Operational discharges would cause substantial and prolonged turbidity and sedimentation, possibly impeding the well-being and permanence of the biota and causing the decrease of live benthic cover.

Finally, the unrestricted use of explosives to remove platforms installed in the vicinity of or on the topographic features could cause turbidity, sedimentation, and shock-wave impacts that would affect reef biota.

The shunting of cuttings and fluids, which would be required by the Topographic Features Stipulation, is intended to limit the smothering and crushing of sensitive benthic organisms by depositing the foreign substances in areas where they could not be displaced by currents onto the topographic features. The impacts from unshunted exploration and development discharges of drill cuttings and drilling fluids within the 1,000-Meter Zone and the 1-Mile Zone would definitely impact the biota of topographic features. Specifically, the discharged materials would cause prolonged events of turbidity and sedimentation, which could have long-term deleterious effects on local primary production, predation, and consumption by benthic and pelagic organisms, biological diversity, and benthic live cover. The unrestricted discharge of drilling cuttings and fluids during development operations within the 3-Mile Zone would be a further source of impact to the sensitive biological resources of the topographic features.

Therefore, in the absence of the Topographic Features Stipulation, a proposed action could cause long-term (10 years or more) adverse impacts to the biota of the topographic features, located in most cases on those portions of the topographic features that are in 85 m and less water depth.

4.3.1.2.2. Chemosynthetic Deepwater Benthic Communities

Physical

The greatest potential for adverse impacts on deepwater chemosynthetic communities would come from those OCS-related, bottom-disturbing activities associated with pipelaying (Chapter 4.1.1.3.8.1), anchoring (Chapter 4.1.1.3.2.1), and structure emplacement (Chapter 4.1.1.3.2), as well as from an accidental seafloor blowout (Chapter 4.4.1.2). Potential impacts from blowouts are discussed in Chapter 4.4.3.2.2. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area.

Considerable mechanical damage could be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affect a small area of the sea bottom. The presence of a conventional structure can also cause scouring of the surficial sediments by near-bottom ocean currents (Caillouet et al., 1981), although this phenomena has not been demonstrated around structures in deep water.

Anchors from support boats and ships (or, as assumed for deeper water depths, from any buoys set out to moor these vessels), floating drilling units, barges used for construction of platform structures, and pipelaying vessels also cause severe disturbances to small areas of the seafloor. The areal extent and severity of the impact are related to the size of the mooring anchor and the length of chain resting on the bottom. Excessive scope and the movement of the mooring chain could disturb a much larger bottom area than an anchor alone, depending on the variety of prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy chemosynthetic communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the central drilling structure. Larger anchors, longer anchor chains/cables and mooring lines, and greater scope for anchoring configurations are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, are expected to be greater for operations that employ anchoring in deep water. Many oil and gas support operations involving ships and boats would not result in anchor impacts on deepwater chemosynthetic communities because the vessels would tie-up directly to rigs, platforms, or mooring buoys. In addition, there are drillships, construction barges, and pipelaying vessels operating in the Gulf of Mexico that rely on dynamic positioning rather than conventional anchors to maintain their position during operations (anchoring would not be a consideration in these situations). The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and current. Anchoring will destroy those sessile organisms actually hit by the anchor or anchor chain during anchoring and anchor weighing, or it could cause destruction of underlying carbonate structures on which organisms rely for dispersion of hydrocarbon sources. While such an area of disturbance may be small in absolute terms, it may be large in relation to the area inhabited by dense chemosynthetic communities.

Normal pipelaying activities in deepwater areas could destroy large areas of chemosynthetic organisms (it is assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed). Since pipeline systems are not as established in deepwater as in shallow water, new installations are required, which will tie into existing systems or bring production directly to shore. Pipelines will also be required to transport product from subsea systems to fixed platforms.

In addition to physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cutting discussed below.

The impacts from bottom-disturbing activities are expected to be relatively rare. Should they occur, these impacts could be quite severe to the immediate area affected, with recovery times as long as 200 years for mature tube-worm communities, with the possibility of the community never recovering.

Discharges

In deep water, discharges of drilling fluids and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Recent information about the effects of surface discharge of drilling fluids (muds) and cuttings at a well in 565 m have been reported by Gallaway and Beaubien (1997). In this instance, a veneer of cuttings was observed scattered over the bottom, in some cases as thick as 20-25 cm. Chemical evidence of SBF components (used during this operation) was found at distances of at least 100 m from the well site (sampling distance was limited by the ROV tether length). Other information from a geophysical survey documented the extent of drilling discharges at several previously drilled oil and gas sites in about 400 m water depths (Nunez, personal communication, 1994). At these sites, the areal coverage of cuttings was found extending from the previous well locations in splay or finger-like projections to a maximum of about 610 m, with an average of about 450 m. An examination of side-scan-sonar records of these splays indicates that they were distributed in accumulations less than 30 cm thick. Effluents from routine OCS operations (not muds or cuttings) in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m.

Impacts from muds and cuttings are also expected from two additional sources: (1) initial well drilling and installation of casing prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various dual-gradient or subsea mudlift drilling techniques in the deep sea. Pre-riser casing installation typically involves 36-in (91-cm) casing that may be set to a depth of 300 ft (91 m) and 26-in (66-cm) casing that may be set to a depth of 1,600 ft (488 m). Jetted or drilled cuttings from the initial wellbore could total as much as 226 m^3 (Halliburton Company, 1995). With dual-gradient drilling techniques, the upper portion of the wellbore will be "drilled" similar to conventional well initiation techniques with cuttings being discharged at the seafloor. After the BOP stack is installed, subsea mudlift pumps will circulate the drilling fluid and cuttings to the surface for conventional well solids control.

Discharges from the dual-gradient drilling operations are expected to be similar to conventional drilling operations. Although the full areal extent and depth of burial from these initial activities are not known, the potential impacts are expected to be localized and short term. Since these areas would occupy a minuscule portion of the available seafloor in the deepwater Gulf of Mexico, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

MacDonald et al. (1995) indicates that the vulnerability of chemosynthetic communities to oil and gas impacts may depend on the type of community present. Tube-worm and mussel communities may be more vulnerable than clam communities because clam communities are vertically mobile (preventing burial) and sparsely distributed. The primary concern related to muds and cuttings discharges is that of burial. Although chemosynthetic organisms thrive with some part of their anatomy located next to or inside of toxic and/or anoxic environments, all chemosynthetic biota (including the symbiotic bacteria) also require oxygen to live. Burial by sediments or rock fragments originating from drilling fluids and cuttings discharges would smother and kill most chemosynthetic organisms (motile clams being one possible exception). Depending on the organism type, just a few centimeters of burial could cause mortality.

The tolerance of various community components to burial is not completely understood and would depend on the depth of burial. Detrimental effects due to burial are expected to decrease exponentially in the same manner that the depth of accumulations of discharges decrease exponentially with distance from the origin. The severity of these impacts is such that there may be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

High-density, Bush Hill-type communities are areas that are considered to be most at risk from oil and gas operations. The disturbance of a Bush Hill-type environment could lead to the destruction of a community from which recovery would occur only over long time intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or would not occur at all. A long span of time is required for the precipitation of enough carbonate rock to support a large population of tube worms. As dense tube-worm communities require hard substrate as well as very active seepage at any point in space, existing communities covered by sediment that are physically damaged would likely never recover (Fisher, 1995).

Information is limited about the vulnerability of tube worms to sedimentation/smothering impact. Individual tube worms are often found buried for more than half the length of their tubes by hemipelagic sediment (MacDonald, 1992). Presumably, this burial occurs over long time intervals. Evidence of catastrophic burial of high-diversity chemosynthetic communities can be found in the paleorecord as documented by Powell (1995), but the importance of this in causing local extinctions was reported as minor. These burials were probably caused by catastrophic seismic events.

Methanotrophic mussel communities have strict chemical requirements that tie them directly to areas of the most active seepage. Physical disturbance of an active mussel bed is thought not to have a long-lasting effect on the community due to high growth rates of individuals (Fisher, 1995). Catastrophic mud burial would be one possible cause of a mussel community death. It is predicted that a mussel community completely eliminated by physical disturbance could be resettled and mature within 20 years.

Reservoir Depletion

There has been some speculation about the potential impact to chemosynthetic communities as a result of oil and gas withdrawal, causing a depletion of the energy source (hydrocarbons) sustaining the chemosynthetic organisms. There is evidence that both removal and reinjection of material into reservoirs that supply seeps on land in California affect the seepage rates. Quigley et al. (1996) reported evidence that suggested offshore California oil production resulted in reduced seepage due to reduction in reservoir pressure. The seeps and faults around which chemosynthetic animals live are supplied from the deep reservoirs that transport the gas or oil to the seafloor through combined effects of buoyancy and pressure. When all of the recoverable hydrocarbons from these reservoirs are withdrawn by production operations (the amount that can be economically extracted by current technology is estimated to be 30% or less of the total hydrocarbons), it is possible that oil and gas venting or seepage would also slow or (less likely) stop. Based on current information, it is not possible to determine whether reduced reservoir pressure would actually reduce the seepage (as observed onshore) or whether there may be enough oil already in the conduit to the surface to continue adequate levels of seepage for long periods, perhaps thousands of years or more. The distribution of chemosynthetic communities is known to occur in association with precise levels and types of chemical gradients at the seafloor; alterations to these gradients may potentially impact the type and distribution of the associated community.

Proposed Action Analysis

Because high-density chemosynthetic communities are generally found only in water depths greater than 400 m, they would not be found in shallow-water areas of the WPA (Subareas W0-60 or W60-200, Table 4-3). Chemosynthetic communities could be found in the deeper water areas (Subareas W200-800, W800-1600, W1600-2400 and W>2400, Table 4-3). Of the 45 known communities, a total of 19 documented chemosynthetic communities are known to occur in the WPA: 1 in the Alaminos Canyon lease area; 5 in the East Breaks lease area; and 13 in the Garden Banks lease area. The levels of projected impact-producing factors for deepwater Subareas W200-800, W800-1600, W1600-2400 and W>2400 are shown in Table 4-3. A range of 4-5 oil and gas production structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2003 and 2042 in the deepwater portions of the WPA as a result of a proposed action. These deepwater production structures are expected to be installed 5-10 years after a proposed lease sale, with a peak annual rate of 1-2.

Notice to Lessees (NTL) 98-11 (superseded by NTL 2000-G20) has been a measure for the protection of chemosynthetic communities since February 1, 1989. Now, NTL 2000-G20 makes mandatory the search for and avoidance of dense chemosynthetic communities (such as Bush Hill-type communities) or areas that have a high potential for supporting these community types, as interpreted from geophysical records. The NTL is exercised on all applicable leases and is not an optional protective measure. Under the provisions of this NTL, lessees operating in water depths greater than 400 m are required to conduct geophysical surveys of the area of proposed activities and to evaluate the data for indications of conditions that may support chemosynthetic communities; if such conditions are indicated, the lessee must either move the operation to avoid the potential communities or provide photodocumentation of the presence or absence of dense chemosynthetic communities of the Bush Hill type. If such communities are indeed present, no drilling operations or other bottom-disturbing activities may take place in the area; if the communities are not present, drilling, anchoring, etc. may proceed. To date, in almost all cases, operators have chosen to avoid any areas that show the potential to support chemosynthetic communities. The basic assumptions underlying the provisions of this mitigation measure are (1) that dense chemosynthetic communities are associated with gas-charged sediments or seeps, (2) that the gas-charged sediment zones or seeps have physical characteristics that will allow them to be identified by geophysical surveys, and (3) that dense chemosynthetic communities are not found in areas where gas-charged sediments or seeps are not indicted on the geophysical survey data. These assumptions have not been totally verified. A definitive correlation between the geophysical characteristics record by geophysical surveys and the presence of chemosynthetic communities has not been proven.

Although there are few examples of field verification, the requirements set forth in NTL 2000-G20 are considered effective in identifying potential areas of chemosynthetic communities. Although there has generally been compliance with NTL 2000-G20, compliance does not guarantee avoidance of high-density communities without visual confirmation in every case. On rare occasions, high-density chemosynthetic community areas may not be properly identified using the geophysical systems and indicators specified in the existing NTL. Oil- or gas-saturated sediments and other related characteristic signatures cannot be determined without high-resolution acoustic records or the interpretation of subsurface 3D seismic data.

Improved definitions and avoidance distances have been released in a new Chemosynthetic Community NTL 2000-G20. Requirements for specific separation distance between potential high-density chemosynthetic communities and both anchors (250-500 ft) and drilling discharge points (1,500 ft) have been included in the revision of the NTL. These new guidelines have also been released in the new Interim Plans NTL (NTL 2000-G10), which became effective May 31, 2000. The potential for any impact could also be lessened by the refinement of techniques used in the interpretations of geophysical records. The use of differential global positioning system (GPS) has also been required on anchor handling vessels when placing anchors near an area that has potential for supporting chemosynthetic communities. As new information becomes available, the NTL will be further modified as necessary.

High-density, Bush Hill-type communities are, as noted above, largely protected from direct physical impacts by the provisions of NTL 2000-G20. A limited number of these communities have been found to date, but it is probable that additional communities exist. Observations of the surface expression of seeps from space images indicate numerous other communities may exist (MacDonald et al., 1993 and 1996). Most chemosynthetic communities are of low density and are relatively widespread throughout the deepwater areas of the Gulf. Physical disturbance or destruction of a small, low-density area would not result in a major impact to chemosynthetic communities as an ecosystem. Low-density communities may occasionally sustain major or minor impacts from discharges of drill muds and cuttings, bottom-disturbing activities, or resuspended sediments. Areas so impacted could be repopulated from nearby undisturbed areas (although this process may be quite slow, especially for vestimentiferans). In light of probable avoidance of all chemosynthetic communities (not just high-diversity types) as required by NTL 2000-G20, the frequency of such impact is expected to be low, and the severity of such an impact is judged to result in minor disturbance to ecological function of the community, with no alteration of ecological relationships with the surrounding benthos. Recolonization after a disturbance would not exactly reproduce the preexisting community prior to the impact, but it could be expected that some similar pattern and species composition would eventually reestablish if similar conditions of sulfide or methane seepage persist after the disturbance.

Summary and Conclusion

Chemosynthetic communities are susceptible to physical impacts from structure placement (including templates or subsea completions), anchoring, and pipeline installation. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

If the presence of a high-density community were missed using existing procedures, potentially severe or catastrophic impacts could occur due to ranking of the sea bottom by anchors and anchor chains and partial or complete burial by muds and cuttings associated with pre-riser discharges or some types of riserless drilling. Variations in the dispersal and toxicity of synthetic-based drilling fluids may contribute to the potential areal extent of these impacts. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, and overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment.

A proposed action in the WPA is expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments located at more than 1,500 ft away as required by NTL 2000-G20.

4.3.1.2.3. Nonchemosynthetic Deepwater Benthic Communities

Physical

Benthic communities other than chemosynthetic organisms could be impacted by OCS-related, bottom-disturbing activities associated with pipelaying (Chapter 4.1.1.3.8.1), anchoring (Chapter 4.1.1.3.3.1), and structure emplacement (Chapter 4.1.1.3.2), as well as from a seafloor blowout (Chapter 4.4.1.4). Potential impacts from blowouts are discussed in Chapter 4.4.3.2.2. These activities cause localized bottom disturbances and disruption of benthic communities in the immediate area. Considerable mechanical damage can be inflicted upon the bottom by routine OCS drilling activities. The physical disturbance by structures related to a drilling operation itself affects a small area of the sea bottom. These impacts are the same as those encountered in shallower continental shelf waters.

Anchors from support boats and ships (or, as assumed in these water depths, from any buoys set out to moor these vessels), floating drilling units, and pipelaying vessels also cause severe disturbances to small areas of the seafloor with the areal extent related to the size of the mooring anchor and length of chain that would rest on the bottom. Excessive scope (length) and movement of the mooring chain could disturb a much larger area of the bottom than would an anchor alone, depending on the prevailing wind and current directions. A 50-m radius of chain movement on the bottom around a mooring anchor could destroy communities in an area of nearly 8,000 m^2. A large area of bottom could also be disturbed by bottom contacts of the entire length of chain or cable for each anchor prior to and during the anchor cable tensioning from the central drilling structure. Larger anchors and additional scope of anchor chain are expected for operations in deep water as compared to operations on the shelf. Therefore, the areal extent of impacts, both for individual anchors and for the entire footprint, are expected to be greater for operations that employ anchoring in deep water. The area affected by anchoring operations will depend on the water depth, length of the chain, size of the anchor, and current. (Many OCS-support operations and activities will not result in anchor impacts to deepwater benthic communities because vessels will tie-up directly to rigs, platforms, or mooring buoys or will use dynamic positioning.) Anchoring will not necessarily directly destroy small infaunal organisms living within the sediment; the bottom disturbance would most likely change the environment to such an extent that the majority of the directly impacted infauna community would not survive (e.g., burial or relocation to sediment layers without sufficient oxygen). In cases of carbonate outcrops or reefs with attached epifauna, the impacted area of disturbance may be small in absolute terms, but it could be large in relation to the area inhabited by hard corals or other organisms that rely on exposed rock substrate.

As described in the previous section for chemosynthetic communities, normal pipelaying activities in deepwater areas could destroy large areas of benthic communities (it is assumed that 0.32 ha of bottom is disturbed per kilometer of pipeline installed.); although, without consideration of chemosynthetic organisms, there are no differences between this activity in deep water as compared to shallow-water operations.

In addition to direct physical impacts, structure removals and other bottom-disturbing activities could resuspend bottom sediments. The potential effects of resuspended bottom sediments are similar to those from the discharge of muds and cuttings discussed below.

Discharges

In deep water, discharges of drilling muds and cuttings at the surface are spread across broader areas of the seafloor and are, in general, distributed in thinner accumulations than in shallower areas on the continental shelf. Recent information about the effects of surface discharge of muds and cuttings at a well in 565 m is reported by Gallaway and Beaubien (1997) and is described in the previous section on chemosynthetic communities. In this instance and in another deepwater survey reported by Nunez (personal communication, 1994), muds and cuttings were documented in accumulations ranging up to 30 cm thick at distances up to 610 m from the well site.

Impact from muds and cuttings are also expected from two additional sources: (1) initial well drilling prior to the use of a riser to circulate returns to the surface; and (2) the potential use of various riserless drilling techniques in the deep sea. Jetted or drilled cuttings discharged at the bottom from the initial wellbore would total as much as 226 m^3 (Halliburton Company, 1995). In the case of some riserless drilling practices, all muds and cuttings from well spudding through total depth would be discharged at the seafloor. Although the full areal extent and depth of burial from these activities is not known, the potential impacts are expected to be localized and short term. Since these areas would occupy only a minuscule portion of the available seafloor in the deepwater Gulf of Mexico, these impacts are not considered significant provided that sensitive communities (e.g., chemosynthetic communities) are avoided.

Burial by sediments or rock fragments originating from drilling muds and cuttings discharges could smother and kill almost all community components of benthic organisms, with the exception of highly motile fish and possibly some crustaceans such as shrimp capable of moving away from the impacted area. Depending on the organism type, just a few centimeters of burial could cause death. The damage would be both mechanical and toxicological. Some types of macrofauna could burrow through gradual accumulations of overlying sediments depending on the toxicological effects of those added materials. Information on the potential toxic effects on various benthic organisms is limited and essentially nonexistent for deepwater taxa.

It can be expected that detrimental effects due to burial would decrease exponentially with distance from the origin. The physical properties of the naturally occurring surface sediment (grain size, porosity, and pore water) could also be changed as a result of discharges such that recolonizing benthic organisms would be comprised of different species than inhabited the area previous to the impact. Although the impacts could be considered severe to the nonmotile benthos in the immediate area affected, they would be considered very temporary. Due to the proximity of undisturbed bottom with similar populations of benthic organisms from microbenthos to megafauna, these impacts would be very localized and reversible at the population level and are not considered significant.

Carbonate outcrops not associated with chemosynthetic communities, such as the deepwater coral “reef” or habitat reported by Moore and Bullis (1960), are considered to be most at risk from oil and gas operations. Due to the fact that deepwater corals require hard substrate, existing communities completely buried by some amount of sediment would likely never recover.

Effluents other than muds or cuttings from routine OCS operations in deep water would be subject to rapid dilution and dispersion and are not projected to reach the seafloor at depths greater than 100 m.

Proposed Action Analysis

For a proposed action in the WPA, 4-5 oil and gas structures ranging from small subsea developments to large developments involving floating, fixed, or subsea structures are estimated to be installed between 2001 and 2040 in Subareas W200-800, W800-1600, W1600-2400, and W>2400 (Table 4-3). These deepwater production structures are expected to be installed 5-10 years after a proposed lease sale, with a peak annual rate of 1-2. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms, such as brittle stars, sea pens, or crabs, would not result in a major impact to the deepwater benthos ecosystem as a whole. Surface discharge of muds and cuttings, as opposed to seafloor discharge, would reduce or eliminate the impact of smothering the benthic communities on the bottom.

Under the current review procedures for chemosynthetic communities, carbonate outcrops are targeted as one possible indication (surface anomaly on 3D seismic survey data) that chemosynthetic seep communities are nearby. Unique communities that may be associated with any carbonate outcrops or other topographical features could be identified via this review along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a geological hazard for any well sites. Any proposed activity in water depth greater than 400 m would automatically trigger the NTL 2000-G20 evaluation described above.

Summary and Conclusion

Some impact to benthic communities from drilling and production activities would occur as a result of physical impact from structure placement (including templates or subsea completions), anchoring, and installation of pipelines regardless of their locations. Megafauna and infauna communities at or below the sediment/water interface would be impacted from the muds and cuttings normally discharged at the seafloor at the start of every new well prior to riser installation. The impact from muds and cuttings discharged at the surface are expected to be low in deep water. Drilling muds would not be expected to reach the bottom beyond a few hundred meters from the surface-discharge location, and cuttings would be dispersed. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be very rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts from OCS activities. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate.

A proposed action in the WPA is expected to cause little damage to the ecological function or biological productivity of the widespread, typical deep-sea benthic communities.

4.3.1.3. Impacts on Water Quality

Activities that are projected to result from a single lease sale in the WPA are given in Table 4-3. The routine activities that will impact water quality include

- discharges during drilling of exploration and development wells;
- workover of a well;
- structure installation and removal;
- discharges during production;
- installation of pipelines;
- service vessel discharges; and
- discharges from support facilities.

The current NPDES General Permit for OCS discharges in USEPA Region 6 (WPA and western CPA) will expire in April 2004.

4.3.1.3.1. Coastal Waters

In coastal waters, the water quality will be impacted by the discharges from the service vessels in port. The types of discharges and regulations were discussed in Chapters 4.1.1.3.4.8 and 4.1.2.1.10.2. Most discharges are treated prior to release, with the exception of ballast water. In coastal waters, bilge water may be discharged with an oil content of 15 ppm or less. The discharges will affect the water quality locally. Estimates of the volume of bilge water that may be discharged are not available.

Supporting infrastructure also discharge into local waterways as a part of their business. The types of onshore facilities were discussed in Chapter 4.1.2.1.10.1. All point-source discharges are regulated by the USEPA, which is the agency responsible for coastal water quality. Run-off is not regulated and may add hydrocarbon and trace-metal pollutants. Data are not available to make estimates of the impact from this type of discharge.

The dredging of navigation channels and the installation of pipelines will result in a temporary increase in the suspended sediment load.

Summary and Conclusion

The primary impacting sources to water quality in coastal waters are point-source and nonpoint-source discharges from support facilities and vessel discharges. The impacts to coastal water quality from a proposed action in the WPA should be minimal as long as all regulatory requirements are met.

4.3.1.3.2. Marine Waters

Drilling Muds and Cuttings

The primary effects on water quality during the drilling of exploratory and development wells result from the discharges of drilling fluids, called “muds,” and cuttings. Table 4-9 gives estimated volumes of muds and cuttings that may be discharged from drilling of an “average” well. The MMS estimates that each lease sale in the WPA will result in 37-115 exploratory and delineation wells and 97-166 development wells being drilled over 35 years. Using the data in Table 4-9, discharges of 500,000-1,000,000 bbl of water-based drilling fluids (WBF) and 70,000-150,000 bbl of associated cuttings are estimated from drilling these wells. The direct discharge of synthetic-based drilling fluids (SBF) is prohibited, however some fluid adheres to the cuttings and an estimated 30,000-70,000 of SBF may be discharged with the estimated 30,000-60,000 bbls of SBF-associated cuttings.

Drill cuttings deposited on the seafloor are representative of the geological formations below the seafloor. The cuttings will include clastic (e.g., sand, silt, and clay), carbonate (e.g., limestone), and evaporite (e.g., salt) rock fragments. They may contain a variety of naturally occurring metals. Silicon, aluminum, iron, and calcium are typically abundant in cuttings, while elements such as cadmium, vanadium, and mercury are found in trace quantities. These elements are unlikely to leach from cuttings into water in any appreciable amounts because they are chemically bound within the rock minerals and therefore not available for biological assimilation. Of environmental concern is the physical impact of the cuttings deposition to the benthic habitat and the potential toxicity of drilling fluid adhered to the cuttings.

The fate and effects of WBF have been extensively studied throughout the world (Engelhardt et al., 1989). The primary concerns for WBF are the increased turbidity in the water column, alteration of sediment characteristics because of coarse material in cuttings, and trace metals. Occasionally, formation fluids may be discharged with the cuttings adding hydrocarbon contamination. Water based drilling fluids are rapidly dispersed in the water column immediately after discharge and descend to the seafloor (Neff, 1987). The greatest effects to the benthos are within 100-200 m, primarily due to the increased coarsening of the sediment by cuttings. Most of the components of drilling fluid have low toxicity with the exception of some trace metals. Barium is the major element in the mud because of the high barite level, but trace amounts of chromium, copper, cadmium, mercury, lead, and zinc are also present. Significant elevations of all these metals except chromium were observed within 500 m of six Gulf of Mexico drilling sites on the continental shelf (Boothe and Presley, 1989). The USEPA guidelines limit the levels of cadmium and mercury in stock barite to 3.0 milligrams/kilogram (mg/kg) and 1.0 mg/kg (dry weight), respectively. A study of chronic impacts from oil and gas activities (Kennicutt, 1995) determined that metals from discharges, including mercury and cadmium, were localized to within 150 m of the structure. Highest levels of metal contaminants were attributed to a platform where discharges are shunted to within 10 m of the bottom.

A recent literature review (Neff et al., 2000) discusses the current knowledge about the fate and effects of SBF on the seabed. Like oil-based drilling fluids (OBF), the SBF do not disperse in the water column and therefore are not expected to adversely affect water quality. They do, however, settle very close to the discharge point, thus affecting the local sediments. Unlike OBF, SBF do not typically contain toxic aromatic compounds. The primary affects are smothering, alteration of grain size, and addition of organic matter, which can result in localized anoxia while the SBF degrade. Different formulations of SBF use different base fluids that degrade at different rates, thus affecting the impact. The SBF cuttings can pass the current discharge criterion for WBF because of their low toxicity. Bioaccumulation tests also indicate that SBF and their degradation products should not significantly bioaccumulate. It is expected that discharged cuttings should degrade within 2-3 years after cessation of discharge. The MMS is currently jointly funding a study of the spatial and temporal effects of discharged cuttings to evaluate the effects. In deep water (>400 m), the use of dual density drilling techniques may result in the discharge of cuttings at the seafloor. The cuttings will not have undergone any cleaning process to remove the drilling fluids, and the impacts of these discharges are not known.

Produced Water

During production, produced water is the primary discharge and will impact water quality by adding hydrocarbons and trace metals to the environment. As discussed in Chapter 4.1.1.3.4.2, the volume of produced water from a facility ranges from 2 to 150,000 bbl/day. With a monthly average of 29 milligrams/liter (mg/l), the volume of added hydrocarbons would be 5.8 x 10^{-5} bbl/day. As a result of a single lease sale in the WPA, MMS estimates that 11-15 production structures will be installed (Table 4-3). Examination of historical data for produced water extracted from blocks in the Gulf of Mexico (Table 4-10) demonstrates that, on average for the past five years, 7,580 bbl of produced water are generated per block per year. As can be seen in Figure 4-3, most of the produced water is extracted in the CPA, with very little in the WPA. Most fields in the WPA produce gas and very little water as opposed to those in the CPA. Assuming that each production structure produces an average of 7,580 bbl/yr of water and the discharge averages 29 mg/l, then approximately 0.2-0.3 bbl/yr of hydrocarbons are added to the environment from each structure. This amount is negligible relative to natural sources of hydrocarbons. Discharges from workovers and other activities are generally mixed with the produced water and therefore must meet the same criteria.

Several studies have been conducted to evaluate the effects of produced-water discharges from platforms on the surrounding water column, sediments, and biota (e.g. Rabalais et al., 1991; Kennicutt, 1995; CSA, 1997b). The GOOMEX study (Kennicutt, 1995) examined the effects of discharges at three natural gas platforms. Effects, including increased hydrocarbons, trace metals, and coarser grain size sediments, were observed within 150 m of the platform. Localized hypoxia was observed during the summer months and attributed to stratification of the water column and increased organic material near the platform. The distribution of contaminants was patchy and there were several variables that could contribute to the observations, specifically sand from cuttings, hydrocarbons, and trace metals in the porewater. It was not possible to make a definitive judgment as to the precise source of observed toxic effects in the benthic community.

A bioaccumulation study (CSA, 1997b) examined trace metals and hydrocarbons in several fish and invertebrate species near platforms on the continental shelf. The produced-water discharge and ambient seawater were also analyzed for the same compounds. Of the 60 target chemicals, only 2 (arsenic and cadmium) were measured in the edible tissues of mollusks at levels above the USEPA risk-based concentrations. The target organic compounds were not present in most tissue samples above the target level. However, radium isotopes were measured in 55 percent of the samples, but at low concentrations.

Measurements of radium in formation water range from 40 to 1,000 picocuries/liter (pCi/l). These values are greater than marine waters, but when formation waters are discharged offshore, the radium is rapidly diluted to ambient concentrations and the higher levels are not seen as a problem (Reid, 1980).

Other Impacting Activities

Platform installation and removal results in localized sediment suspension. Also, the installation of pipelines can increase the local total suspended solids. These activities result in only a temporary adverse effect on water quality.

Supply-vessel traffic affects water quality through discharges of bilge water, ballast water, and domestic and sanitary wastes. Bilge water and sanitary wastes are treated before discharge. Ballast water is uncontaminated water but may come from a source with properties, such as lower or higher salinity, different from those of the receiving waters. Estimates of the volumes of these discharges are not available.

Summary and Conclusion

During exploration and development drilling activities, the primary impacting sources to marine water quality are discharges of drilling fluids and cuttings. Impacting discharges during production activities are produced water and supply-vessel discharges. Impacts to marine waters from a proposed action in the WPA should be minimal as long as all regulatory requirements are followed.

4.3.1.4. Impacts on Air Quality

The following activities will potentially degrade air quality: platform construction and emplacement; platform operations; drilling activities; flaring; seismic-survey and support-vessel operations; pipeline laying and burial operations; evaporation of volatile petroleum hydrocarbons during transfers and from surface oil slicks; and fugitive emissions. Supporting materials and discussions are presented in Chapters 3.1.1 (description of the coastal air quality status of the Gulf coastal area), 4.1.1.3.6 (air emissions), 4.1.1.3.9 (hydrogen sulfide), and 9.1.3 (description of the meteorology of the northern Gulf of Mexico). The parameters of this analysis are emission rates, surface winds, atmospheric stability, and the mixing height.

Emissions of certain air pollutants are known to be detrimental to public health and welfare. Some of these pollutants are directly emitted into the air, while others are formed in the atmosphere through chemical reactions. Nitric oxide and nitrogen dioxide constitute nitrogen oxide (NO_x) emissions. Nitrogen dioxide, a by-product of all combustion processes, is emitted from sources such as internal combustion engines, natural gas burners, and flares. Nitrogen dioxide is a precursor pollutant involved in photochemical reactions that yield ozone. Nitrogen dioxide is an irritating gas that may increase susceptibility to infection and may constrict the airways of people with respiratory problems. Further, nitrogen dioxide can react with water to form nitric acid, which is harmful to vegetation and materials, as a result of increased acidity in precipitation (i.e., the acid rain).

Carbon monoxide (CO) is a by-product of incomplete combustion, primarily contained in engine exhaust. Carbon monoxide is readily absorbed into the body through the lungs, where it reacts with hemoglobin in the blood, reducing the transfer of oxygen within the body. CO particularly affects people with cardiovascular and chronic lung diseases.

Sulfur dioxide (SO_2) may cause constriction of the airways and particularly affects individuals with respiratory diseases. Sulfur dioxide reacts in the atmosphere, principally with water vapor and oxygen, producing sulfuric acid, which along with nitric acid are the major constituents of acid rain. Acid rain can be harmful to animals, vegetation, and materials. The flaring of natural gas containing hydrogen sulfide (H_2S) and the burning of liquid hydrocarbons containing sulfur (Chapter 4.1.1.3.9) result in the formation of SO_2. The amount of SO_2 produced is directly proportional to the sulfur content of the hydrocarbons being flared or burned.

The concentration of the H_2S varies substantially from formation to formation and even varies to some degree within the same reservoir. In the deepwater projects, the natural gas has been mainly sweet (i.e., low in sulfur content), but the oil is averaging between 1 and 4 percent sulfur content by weight.

Flaring of sour gas is of concern because it could significantly impact onshore areas, particularly when considering the short-duration averaging periods (3 and 24 hr) for SO_2. The combustion of liquid hydrocarbon fuel is the primary source of sulfur oxides (SO_x), when considering the annual averaging period; however, impacts from high-rate well cleanup operations can generate significant SO_2 emissions. To prevent inadvertently exceeding established criteria for SO_2 for the 3-hr and 24-hr averaging periods, all incinerating events involving H_2S or liquid hydrocarbons are evaluated individually during the postlease process.

Volatile organic compounds (VOC's) are precursor pollutants involved in a complex photochemical reaction with NO_x in the atmosphere to produce ozone. The primary sources of VOC's result from venting and evaporative losses that occur during the processing and transporting of natural gas and petroleum products. A more concentrated source of VOC's is from vents on glycol dehydrator stills.

Particulate matter is comprised of finely divided solids or liquids such as dust, soot, fumes, and aerosols. The PM_{10} particles are small enough to bypass the human body's natural filtration system and can be deeply inhaled into the lungs, affecting respiratory functions. The PM_{10} can also affect visibility, primarily due to scattering of light by the particles and, to a lesser extent, light absorption by the particles.

Ozone is a nearly colorless gas with a faint but distinctive odor, somewhat similar to chlorine. It is formed in the troposphere (i.e., lower level of the atmosphere) from complex chemical reactions involving VOC's and NO_x in the presence of sunlight. At ground level, ozone can cause or aggravate respiratory problems, interfere with photosynthesis, and can damage vegetation and crack rubber. Children, the elderly, and healthy people who work or exercise strenuously outdoors are particularly sensitive to elevated ozone concentrations. In the upper atmosphere (i.e., above the troposphere), ozone is essential to life as we know it. The upper ozone layer shields the Earth's surface from harmful ultraviolet radiation. Depletion of the upper ozone layer is one of the most complex environmental issues facing the world today. This analysis will not include impacts on upper atmospheric ozone.

Emissions of air pollutants will occur during exploration, development, and production activities. The profile of typical emissions for exploratory and development drilling activities (Chapter 4.1.1.3.6) shows that emissions of NO_x are the most prevalent pollutant of concern. These emission estimates are based on a drilling scenario of a 4,115-m (13,500-ft) hole during exploration activities and a 3,050-m (10,000-ft) hole during development activities. Emissions during exploration are higher than emissions during development due to power requirements for drilling a deeper hole.

Platform emission rates for the Gulf of Mexico region (Chapter 4.1.1.3.6) are provided from the 1992 emission inventory of OCS sources compiled by MMS (Steiner et al., 1994). This compilation was based on information from a survey of 1,857 platforms, which represented an 85 percent response rate. Since these responses included all the major oil and gas production facilities, they were deemed representative of the type of emissions to be associated with a platform. The NO_x and VOC's are the primary pollutants of concern, since both are considered to be precursors to ozone. Emission factors for other activities such as support vessels, helicopters, tankers, and loading and transit operations were obtained from Jacobs Engineering Group, Inc. (1989) and USEPA AP-42 (1985).

Flaring is the venting and/or burning of natural gas from a specially designed boom. Flaring systems are also used to vent gas during well testing or during repair/installation of production equipment. The MMS operating regulations provide for some limited volume, short duration flaring or venting of some natural gas volumes upon approval by MMS. These operations may occur for short periods (typically 2-14 days) as part of unloading/testing operations that are necessary to remove potentially damaging completion fluids from the well bore, to provide sufficient reservoir data for the operator to evaluate a reservoir and development options, and in emergency situations. Emissions from flaring were included in the emissions tables and in the modeling analysis (since platform emissions included flaring along with all other sources).

Accidents, such as oil spills, blowouts and pipeline ruptures, are another source of emissions related to OCS operations. The potential impacts from these accidental events are discussed in Chapter 4.4.3.4.

Once pollutants are released into the atmosphere, atmospheric transport and dispersion processes begin circulating the emissions. Transport is carried out by the prevailing net wind circulation. During summer, the wind regime in the WPA is predominantly onshore at mean speeds of 3-4 m/sec (6.7-9.0 mph). Average winter winds are complex. The predominant winds blow from the north and south, averaging 4-8 m/sec (8.9-17.9 mph); the east and west winds are weaker and less frequent, although the easterly component is more common than the westerly component. Since the north and south winds nearly balance each other out, the resulting mean wind vector is from the northeast at about 2 m/sec (4.4 mph).

Dispersion depends on emission height, atmospheric stability, mixing height, exhaust gas temperature and velocity, and wind speed. For emissions inside the atmospheric boundary layer, the vertical heat flux, which includes effects from wind speed and atmospheric stability (via air-sea temperature differences), is a better indicator of turbulence available for dispersion (Lyons and Scott, 1990). Heat flux calculations in the WPA (USDOI, MMS, 1988) indicate an upward flux year-round, being highest during winter and lowest in summer.

The mixing height is very important because it determines the space available for spreading the pollutants. The mixing height is the height, above the surface, of the top of the layer through which vigorous vertical mixing occurs. Vertical mixing is most vigorous during unstable conditions. Vertical motion is suppressed during stable conditions; these stagnant conditions generally result in the worst periods of air quality. Although mixing height information throughout the Gulf of Mexico is scarce, measurements near Panama City (Hsu, 1979) show that the mixing height can vary between 400 and 1,300 m, with a mean of 900 m. The mixing height tends to be higher in the afternoon, more so over land than over water. Further, the mixing height tends to be lower in winter, with daily changes smaller than in summer.

Proposed Action Analysis

The emissions in tons of the criteria pollutants over the 40-year life of a proposed action are indicated in Table 4-33. The major pollutant emitted is NO_x, while PM_{10} is the least emitted pollutant. Combustion-intensive operations such as platform operations, well drilling, and service-vessel activities contribute mostly NO_x; platform operations are also the major contributors of VOC emissions. Platform construction emissions contribute appreciable amounts of all pollutants over the life of a proposed action. These emissions are temporary in nature and generally occur for a period of 3-4 months. Typical construction emissions result from the derrick barge placing the jacket and various modular components and from various service vessels supporting this operation. Drilling operations contribute considerable amounts of all pollutants. These emissions are temporary in nature and typically occur over a 40-day drilling period. Support activities for OCS activities include crew and supply boats, helicopters, and pipeline vessels; emissions from these sources consist mainly of NO_x and CO. These emissions are directly proportional to the number and type of OCS operations requiring support activities. Most emissions from these support activities occur during transit between the port and the offshore facilities; a smaller percentage of the emissions occur during idling at the platform. Platform and well emissions were calculated using the integration of projected well and platform activities over time.

Total emissions for each offshore subarea in the WPA due to a proposed action are presented in Table 4-34. Activities projected for Subarea W0-60 would generate the greatest amounts of emissions, while the other five subareas are estimated to generate lower amounts of pollutants. Pollutants are distributed to subareas proportional to the projected number of production structure installations slated for those areas.

The total pollutant emissions per year are not uniform. During the early years of a proposed action, emissions would be small. Emissions increase over time with platform emplacements and increasing production. After reaching a maximum, emissions would decrease as wells are depleted and abandoned, platforms are removed, and service-vessel trips and other related activities are no longer needed.

The peak-year emissions in tons per year for the criteria pollutants are indicated in Table 4-35. The peak-year emissions for a proposed action in the WPA are projected to occur in the 2015-2018 timeframe. The peak emissions are calculated by combining peak-year activity total emissions for exploratory wells, development wells, and platforms over the life of a proposed action, and superimposing projected peak activity for support vessels and other emissions into that peak year. Peak well-drilling activities and platform emissions are not necessarily simultaneous. It is assumed for this analysis that total well and platform peak-year emissions combined with vessels and other emissions occur simultaneously. Use of the peak emissions provides the most conservative estimates of potential impacts to onshore air quality. The main pollutant emitted is NO_x, with platforms and service vessels being the primary source.

Projected peak-year activities would generate the greatest amounts of emissions in offshore Subarea W0-60 (Table 4-36). Pollutants are distributed to offshore subareas proportional to the projected number of production structure installations slated for each subarea.

The MMS regulations (30 CFR 250.44) do not establish annual significance levels for CO and VOC. For CO, a comparison of the projected emission rate to the MMS exemption level will be used to assess impacts. The formula to compute the emission rate in tons/yr for CO are $3{,}400 \bullet D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. Offshore Texas, the CO exempt emission level is 14,819 tons/yr at the State boundary line of 3 leagues, which is greater than CO peak emissions from the whole WPA.

The VOC emissions are best addressed as their corresponding ozone impacts, which were studied in the Gulf of Mexico Air Quality Study (GMAQS). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas including the Houston/Galveston, Port Arthur/Lake Charles and Baton Rouge areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities and the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The activities under this proposed action will not result in a doubling of the emissions, and because the proposed activities are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995). Additionally, 30 CFR 250.303(f)(2) requires that if a facility would significantly impact (defined as exceeding the MMS significance levels) an onshore nonattainment area, then it would have to reduce its impact fully through the application of the best available control technology (BACT) and possibly through offsets as well.

The implementation of the new 8-hour ozone standard, a Federal standard that is still pending court action, may affect the ozone level in coastal areas from OCS emissions. The new 8-hour ozone standard (0.08 ppm) is more stringent than the existing 1-hour standard. Thus, if the new 8-hour standard is implemented, it could result in more areas being classified as nonattainment for ozone. This may include a number of parishes in Louisiana as well as counties in Mississippi and the Florida Panhandle.

A new modeling analysis will be conducted using OCS emissions data of the year 2000. The results will be used to investigate the potential effects of OCS emissions on 8-hour average ozone levels in the near future. However, it is expected that the impact on ozone level due to contribution from OCS emissions sources would be minor, because the emission from all sources would remain about the same level or less (sea also Draft EIS on the proposed OCS Oil and Gas Leasing Program: 2002-2007; USDOI, MMS, 2001c).

It is estimated that over 99 percent of the gas and oil will be piped to shore terminals. Thus, fugitive emissions associated with tanker and barge loadings and transfer will be small, as will the associated exhaust emissions. Safeguards to ensure minimum emissions from any offloading and loading operations of OCS crude oil production from surface vessels at ports have been adopted by the State of Texas. Current industry practice is to transport OCS-produced oil and gas via pipeline whenever feasible.

The MMS studied the impacts of offshore emissions using the Offshore and Coastal Dispersion (OCD) Model. Three large areas in the WPA were modeled. The limiting factor on the size of each area was the run time needed to process the number of sources. The areas modeled were offshore Corpus Christi Bay, Matagorda Bay, and Galveston Bay. The receptors were set along the coastline and also a short distance inland in order to capture coastal fumigation. Circular areas were chosen to reduce edge effect. The areas were selected to best capture most of the offshore sources and to focus on the highly concentrated areas of development. Emissions for a proposed action were projected and compared to the emission inventory for the GMAQS. Ratios between these two sets of total emission rates were developed and applied to the GMAQS inventory; this modified inventory was then used as the database for the sources for the OCD modeling. Only the onshore maximum concentrations reported for all of the runs are discussed. The results of the runs are reported in Table 4-37. The results are also compared with the federally allowable increases in ambient concentrations as regulated by 30 CFR 250.45(g) and 40 CFR 51.166(c).

Table 4-37 lists the highest predicted contributions to onshore pollutant concentrations from OCS activities, as well as the maximum allowable increases over a baseline concentration established under the air quality regulations. While the table shows that OCS activities would result in concentration increases that are well within the maximum allowable limits for a Class II area, a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and corresponding concentration and do not count in the determination of the maximum allowable increment. The PM_{10} are emitted at a substantially smaller rate than NO_2 and SO_2; hence, impacts from PM_{10} would be expected to be even smaller since chemical decay was not employed in this dispersion modeling. As a proposed action in the WPA would represent approximately 1 percent of OCS activities in the WPA, emissions from activities resulting from a proposed action would be substantially below the maximum allowable limits for a Class II area.

Gaseous and fine particulate matter in the atmosphere can potentially degrade the atmospheric visibility. The visibility degradation is primarily due to the presence of particulates with the size in the range of 1 to 2 microns. The sources of these particulates may come from fuel burning and the chemical transformation of the atmospheric constituents. The chemical transformation of NO_2, SO_2, and VOC may produce nitrates, sulfates, and carbonaceous particles. High humidity also may contribute tot he visibility impairment in the Gulf coastal areas. Visibility is considered an important resource in the Breton National Wilderness Area, a Federal Class I area. Because future air emission from all sources in the area are expected to be about the same level or less, it is expected that the impact on visibility due to the presence of fine particulates would be minor.

Suspended particulate matter is important because of its potential in degrading visibility and because of its potential health effects at high concentrations. The impact depends on emission rates and particle size. Particle size represents the equivalent diameter (diameter of a sphere) that will have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991), with two peaks located at diameters smaller than 2 μm and a third peak with diameters larger than 2 μm. Particles with diameters of 2 μm or larger settle very close to the source (residence time of approximately ½ day, Lyons and Scott, 1990). For particles smaller than 2 μm, which do not settle fast, wind transport determines their impacts. Projected PM_{10} concentrations are expected to have a low impact.

Summary and Conclusion

Emissions of pollutants into the atmosphere from the activities associated with a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emission heights, emission rates, and the distance of these emissions from the coastline. Emissions from proposed-action activities are not expected to have concentrations that would change onshore air-quality classifications. The OCD modeling results show that increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than the maximum increases allowed in the PSD Class II areas.

4.3.1.5. Impacts on Marine Mammals

The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and jetsam and flotsam from service vessels and OCS structures. These major factors may affect marine mammals in the Gulf at several temporal and spatial scales that result in acute or chronic impacts.

Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by the USEPA's NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; NRC, 1983; Kennicutt, 1995). Any potential impacts from drilling fluids would be indirect, either as a result of impacts to prey species or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of marine mammals or species lower in the marine food web. Marine mammals generally are inefficient assimilators of petroleum compounds in prey (Neff, 1990). Analyses of samples from stranded Gulf of Mexico bottlenose dolphins showed high levels of organochlorides and heavy metals (e.g., Salata et al., 1995; Kuehl and Haebler, 1995). Many heavy metals presumably are acquired from food, but the ultimate sources are poorly known (API, 1989). Adequate baseline data is not available to determine the significant sources of contaminants that accumulate in Gulf cetaceans or their prey, due in no small part to the fact that contaminants are introduced into the Gulf of Mexico from a suite of national and international watersheds. Many cetaceans are wide-ranging animals, which also compounds the problem. It is known that neritic cetacean species tend to have higher levels of metals than those frequenting oceanic waters (Johnston et al., 1996). Oceanic cetaceans feeding on cephalopods have higher levels of cadmium in their tissues than comparable fish-eating species (Johnston et al., 1996). There also is, in many cases, a striking difference between the relatively high mercury levels in the toothed whales and the lower levels found in baleen whales, which is probably attributable to the different prey species consumed by baleen whales, as well as differences in the habitat (Johnston et al., 1996).

Aircraft

Aircraft overflights in proximity to cetaceans can elicit a startle response. Whales often react to aircraft overflights by hasty dives, turns, or other abrupt changes in behavior. Responsiveness varies widely depending on factors such as the activity the animals are engaged in and water depth (Richardson et al., 1995). Whales engaged in feeding or social behavior are often insensitive to overflights. Whales in confined waters, or those with calves, sometimes seem more responsive. This behavioral response could be a result of noise and/or visual disturbance. The effects appear to be transient, and there is no indication that long-term displacement of whales occur. Absence of conspicuous responses to an aircraft does not show that the animals are unaffected; it is not known whether these subtle effects are biologically significant (Richardson and Würsig, 1997).

Vessel Traffic

Of 11 species known to have been hit by vessels, fin whales are struck most frequently, sperm whales are hit commonly, and records of collisions with Bryde's whales are rare (Laist et al., 2001). Fin whales are rare, sperm whales are common, and Bryde's whales are uncommon in the Gulf of Mexico.) Data compiled of 58 collisions indicate that all sizes and types of vessels can collide with whales; the majority of collisions appear to occur over or near the continental shelf; most lethal or severe injuries are caused by ships 80 m or longer; whales usually are not seen beforehand or are seen too late to be avoided; and most lethal or severe injuries involve shops traveling 14 kn or faster. Vessel collisions can significantly affect small populations of whales, such as northern right whales in the western North Atlantic (Laist et al., 2001).

Increased traffic from support vessels involved in survey, service, or shuttle functions will increase the probability of collisions between vessels and marine mammals occurring in the area. These collisions can cause major wounds on cetaceans and/or be fatal (e.g., northern right whale, Kraus, 1990, and Knowlton et al., 1997; bottlenose dolphin, Fertl, 1994; sperm whale, Waring et al., 1997). Debilitating injuries may have negative effects on a population through impairment of reproductive output. Slow-moving cetaceans (e.g., northern right whale) or those that spend extended periods of time at the surface in order to restore oxygen levels within their tissues after deep dives (e.g., sperm whale) might be expected to be the most vulnerable. Smaller delphinids often approach vessels that are in transit to bow-ride. It would seem that delphinids are agile enough to easily avoid being struck by vessels. However, there are occasions that dolphins are either not attentive (due to behaviors they are engaged in or perhaps because of their age/health) or there is too much vessel traffic around them, and they are struck by screws. Nowacek and Wells (2001) found that bottlenose dolphins had longer interbreath intervals during boat approaches compared to control periods (no boats present within 100 m) in a study conducted in Sarasota Bay, Florida. They also found that dolphins decreased interanimal distance, changed heading, and increased swimming speed significantly more often in response to an approaching vessel than during control periods.

Toothed whales (and baleen whales, to a lesser extent) show some tolerance of vessels, but may react at distances of several kilometers or more when confined by environmental features or when they learn to associate the vessel with harassment. Evidence suggests that certain whales have reduced their use of certain areas heavily utilized by ships (Richardson et al., 1995), possibly avoiding or abandoning important feeding areas, breeding areas, resting areas, or migratory routes. The continued presence of various cetacean species in areas with heavy boat traffic indicates a considerable degree of tolerance to ship noise and disturbance. An experiment involving playback of low-frequency sound in the Canary Islands suggests that sperm whales from an area that has heavy vessel traffic have a high tolerance for noise (Andre et al., 1997). There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or growth, unless they occur frequently.

Long-term displacement of animals, in particular baleen whales, from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance are stressed or otherwise affected in a negative, but inconspicuous way (Richardson et al., 1995). Stress or "alert" responses could occur quite early during an encounter. For example, Myrick and Perkins (1995) found stress responses occurring as early as the chase stage in purse-seine netting on dolphins.

It is possible that manatees could occur in coastal areas where vessels traveling to and from the leased sites could affect them. If a manatee should be present where there is vessel traffic, they could be injured or killed by a boat striking them (Wright et al., 1995). Inadequate hearing sensitivity at low frequencies may be a contributing factor to the manatees' inability to effectively detect boat noise and avoid collisions with boats (Gerstein et al., 1999).

Drilling and Production Noise

Exploration, delineation, and production structures, as well as drillships, produce an acoustically wide range of sounds at frequencies and intensities that can be detected by cetaceans. Some of these sounds could mask cetaceans' reception of sounds produced for echolocation and communication. Odontocetes use sounds at frequencies that are generally higher than the dominant sounds generated by offshore drilling and production activities. Low-frequency hearing has not been studied in many species, but bottlenose dolphins can hear sounds at frequencies as low as 40-125 Hz. Below 1 kHz, where most OCS-industry noise energy is concentrated, sensitivity seems poor (Richardson et al., 1995). Pilot whales and sperm whales changed their behavior (in particular, ceased vocalizations) during low-frequency transmissions from the Heard Island Feasibility Test in the southern Indian Ocean (Bowles et al., 1994); this throws doubt on the assumed insensitivity of odontocete hearing at low frequencies. Baleen whales mainly utter low-frequency sounds that overlap broadly with the dominant frequencies of many industrial sounds. There are indirect indications that baleen whales are sensitive to low- and moderate-frequency sounds (Richardson et al., 1995). Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies, averaging 5 Hz and 10-500 Hz, respectively (Richardson et al., 1995). There is particular concern for baleen whales that are apparently more dependent on low-frequency sounds than are other marine mammals; many OCS-industry sounds are concentrated at low frequencies. Drillships produce higher levels of underwater noise than other types of platforms. There are few published data on underwater noise levels near production platforms and on the marine mammals near those facilities (Richardson et al., 1995). However, underwater strong noise levels may often be low, steady, and not very disturbing (Richardson et al., 1995). Stronger reactions would be expected when sound levels are elevated by support vessels or other noisy activities (Richardson et al., 1995).

Human-made sounds may affect the ability of marine mammals to communicate and to receive information about their environment (Richardson et al., 1995). Such noise may interfere with or mask the sounds used and produced by these animals and thereby interfere with their natural behavior. These sounds may frighten, annoy, or distract marine mammals and lead to physiological and behavioral disturbances. The response threshold may depend on whether habituation (gradual waning of behavioral responsiveness) or sensitization (increased behavioral responsiveness) occurs (Richardson et al., 1995). Sounds can cause reactions that might include disruption of marine mammals' normal activities (behavioral and/or social disruption) and, in some cases, short- or long-term displacement from areas important for feeding and reproduction (Richardson et al., 1995). The energetic consequences of one or more disturbance-induced periods of interrupted feeding or rapid swimming, or both, have not been evaluated quantitatively. Energetic consequences would depend on whether suitable food is readily available. Of the animals responding to noise, females in late pregnancy or lactating would probably be most affected. Human-made noise may cause temporary or permanent hearing impairment in marine mammals if the noise is strong enough. Such impairment would have the potential to diminish the individual's chance for survival. Tolerance of noise is often demonstrated, but this does not prove that the animals are unaffected by noise; for example, they may become stressed, making the animal(s) more vulnerable to parasites, disease, environmental contaminants, and/or predation. Noise-induced stress is possible, but little studied in marine mammals. Aversive levels of noise might cause animals to become irritable, affecting feed intake, social interactions, or parenting; all of these effects might eventually result in population declines (Bowles, 1995).

Structure Removals

A limited amount of information is available on the effects of explosions on marine mammals (O'Keeffe and Young, 1984; Ketten, 1998). The shock wave produced by explosions can cause physical damage to nearby animals. The potential for injury is associated with gas-containing internal organs, such as the lungs and intestines (Yelverton et al., 1973). Data are limited regarding blast-induced auditory damage. Explosions and shock waves and their intense transient sound field have the ability to produce blast injury and acoustic trauma in marine mammals (Ketten, 1995 and 1998). Consequences of hearing damage may range from subtle modification of certain behaviors that require a modicum of hearing ability to acute, where concussive effects may lead to death (Ketten, 1995).

For example, two humpback whales were found with damage to their ear bones following an explosion in Newfoundland (Ketten et al., 1993). Yet other humpback whales in Newfoundland, foraging in an area of explosive activity, showed little behavioral reaction to the detonations in terms of decreased residency, overall movements, or general behavior, though orientation ability appeared to be affected (Todd et al., 1996). Todd et al. (1996) suggested caution in interpretation of the lack of visible reactions as indication that whales are not affected or harmed by an intense acoustic stimulus; both long- and short-term behavior as well as anatomical evidence should be examined. The researchers interpreted increased entrapment rate of humpback whales in nets as the whales being influenced by the long-term effects of exposure to deleterious levels of sound.

Odontocetes cannot hear well in the frequencies emitted by explosive detonations (Richardson et al., 1995). The animals may not be able to hear the pulse generated from open-water detonations of explosive charges because it is very brief (*Federal Register*, 1995a). Sublethal effects would include a startle response. Even if dolphins are not capable of hearing the acoustic signature of the explosion, physiological, pathological, or behavioral responses to detonations may still result. The NMFS (USDOC, NMFS, 1995) cites such examples as detection of low-frequency sound by some mechanism other than conventional hearing and harassment due to tactile stings from the shock wave accompanying detonations. Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995a). Because of its temporary effect, no impacts to higher life forms are expected, and, because of its temporary and localized nature, biomagnification is unlikely.

The extent of potential injury is dependent upon the amount of explosive used, distance from the charge, and body mass of the cetacean. As explained in detail in the USDOC, NMFS (1995), it may be assumed that marine mammals more than 3,000 ft (910 m) from structures to be removed would avoid injury caused by explosions. There is no evidence linking dolphin injuries or deaths in the Gulf to explosive removal of structures (Klima et al., 1988; Gitschlag et al., 1997). In October 1995, NMFS issued regulations authorizing and governing the taking of bottlenose and spotted dolphins incidental to the removal of gas drilling and production structures in State waters and on the Gulf of Mexico OCS for a period of five years (*Federal Register*, 1995a). Those regulations are currently being reviewed and revised by MMS and NOAA Fisheries.

In order to minimize the likelihood of removals occurring when cetaceans may be nearby, MMS has issued guidelines (NTL 2001-G08) for removing offshore structures with explosives to offshore operators. These guidelines specify explosive removals only during daylight hours, staggered detonation of explosive charges, placement of charges 5 m below the seafloor, and pre- and post-detonation aerial surveys within one hour before and after detonation. Trained observers watch for sea turtles and marine mammals in the vicinity of the structures to be removed.

Seismic Surveys

The MMS has almost completed a programmatic EA on G&G permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference. Seismic surveys use a high-energy noise source. During Irish Sea seismic surveys, pulses were audible on hydrophone recordings above the highly elevated background ship noise at least up to the 20-km range (Goold and Fish, 1998). Although the output of airgun arrays is usually tuned to concentrate low-frequency energy, a broad frequency spectrum is produced, with significant energy at higher frequencies (e.g., Goold and Fish, 1998). These energies encompass the entire audio frequency range of 20 Hz to 20 kHz (Goold and Fish, 1998) and extend well into the ultrasonic range up to 50 kHz.

Baleen whales seem quite tolerant of low- and moderate-level sound pulses from distant seismic surveys but exhibit behavioral changes in the presence of nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing, respiration, and dive cycles have been noted (Richardson et al., 1995; Richardson, 1997). Response appears to diminish gradually with increasing distance and decreasing sound level (Richardson, 1997). Bowhead and gray whales often show strong avoidance within 6-8 km of an airgun array. Humpback whales off western Australia were found to change course at 3-6 km from an operating seismic survey vessel, with most animals keeping a standoff range of 3-4 km (McCauley et al., 1998a and b). Humpback whale groups containing females involved in resting behavior in key habitat types were more sensitive than migrating animals and showed an avoidance response estimated at 7-12 km from a large seismic source (McCauley et al., 2000). Whales exposed to sound from distant seismic survey ships may be affected even though they remain in the area and continue their normal activities (Richardson et al., 1995). For baleen whales, in particular, it is not known (1) whether the same individuals return to areas of previous seismic exposure, (2) whether seismic work has caused local changes in distribution or migration routes, or (3) whether whales that tolerate strong seismic pulses are stressed (Richardson et al., 1995). Individually identified gray whales remained in Puget Sound long after the seismic survey (as is normal), despite being exposed to noise (Calambokidis and Osmek, 1998; Bain et al., 1999).

Goold (1996) found that acoustic contacts with common dolphins in the Irish Sea dropped sharply as soon as seismic activity began, suggesting a localized disturbance of dolphins. It was also estimated that seismic energy from the 2,120-in^3 airgun array in a shelf sea environment was safe to common dolphins at a radius from the gun array of 1 km (Goold and Fish, 1998). Given the high, broadband seismic-pulse power levels across the entire recorded bandwidth and the known auditory thresholds for several dolphin species, Goold and Fish (1998) considered such seismic emissions to be clearly audible to dolphins across a bandwidth of tens of kilohertz and at least out to the 8-km range.

Sperm whales during the Heard Island Feasibility Test were found to cease calling during some (but not all) times when seismic pulses were received from an airgun array >300 km away (Bowles et al., 1994) (whether sperm whales were responding directly to the seismic pulses is not known). In contrast, there are observations of sperm whales in the Gulf continuing to vocalize while seismic pulses are ongoing (Evans, personal communication, 1999). One report of Gulf of Mexico sperm whales suggested that the animals may have moved 50+ km away in response to seismic pulses (Mate et al., 1994), but further work suggests that the animals may not have moved in response to the sound, but perhaps relative to oceanographic features and prey distribution. It is unclear whether the well-documented, continued occurrence of sperm whales in the area off the mouth of the Mississippi River is a consequence of low sensitivity to seismic sound or a high motivation to remain in the area. Sperm whales have historically occupied this area; their continued presence might suggest habituation to the seismic signals. During the MMS-sponsored GulfCet II study on marine mammals, results showed that the cetacean sighting rate did not change significantly due to seismic exploration signals (Davis et al., 2000). The analysis of the results was unable to detect small-scale (<100 km) changes in cetacean distribution. Results of passive acoustic surveys to monitor sperm whale vocal behavior and distribution in relation to seismic surveys in the northeast Atlantic revealed few, if any, effects of airgun noise (Swift et al., 1999). The authors suggested that sperm whales in that area may be habituated to seismic surveys and/or responses may occur at scales to which the research was not sensitive.

No obvious behavior modifications relative to the seismic activity were recorded during the majority of the small odontocete observations made during marine mammal monitoring carried out during a 3D seismic survey offshore California in late 1995 (Arnold, 1996). There was also no observable behavior modification or harassment of large whales attributable to the sound effects of the survey (Arnold, 1996).

There are no data on auditory damage in marine mammals relative to received levels of underwater sound pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals given a study of damage risk criteria; the transitory nature of seismic exploration; the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals; and the avoidance responses that occur in at least some baleen whales, when exposed to certain levels of seismic pulses (Richardson et al., 1995).

Flotsam and Jetsam

In recent years, there has been increasing concern about manmade debris (discarded from offshore and coastal sources) and its impact on the marine environment (e.g., Shomura and Godfrey, 1990; Laist, 1997). Both entanglement in and ingestion of debris has caused the death or serious injury of marine mammals (Heneman and the Center for Environmental Education, 1988; MMC, 1998). The debris items most often found entangling animals are net fragments and monofilament line from commercial and recreational fishing boats, as well as strapping bands and ropes probably from all types of vessels. Plastic bags and small plastic fragments are the most commonly reported debris items in the digestive tracts of cetaceans and manatees (e.g., Barros and Odell, 1990; Tarpley and Marwitz, 1993; Laist, 1997; MMC, 1998). Many types of plastic materials are used during drilling and production activities; the offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). The MMS prohibits the disposal of equipment, containers, and other materials into coastal and offshore waters by lessees (30 CFR 250.40). Prohibition of the discharge and disposal of vessel- and offshore structure-generated garbage and solid waste items into both offshore and coastal waters was established January 1, 1989, via the enactment of MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which the USCG enforces. Accidental release of debris from OCS activities is known to occur offshore, and such flotsam may injure or kill cetaceans.

Proposed Action Analysis

The major impact-producing factors affecting marine mammals as a result of routine OCS activities include the degradation of water quality from operational discharges; noise generated by helicopters, vessels, operating platforms, and drillships; vessel traffic; explosive structure removals; seismic surveys; and jetsam and flotsam from service vessels and OCS structures.

Information on drilling fluids, drill cuttings, and produced waters that would be discharged offshore as a result of a proposed action is provided in Chapter 4.1.1.3.4. Some effluents are routinely discharged into offshore marine waters. It is expected that cetaceans may have some interaction with these discharges. Direct effects to cetaceans are expected to be sublethal. It should be noted, however, that any pollution in the effluent could poison and kill or debilitate marine mammals and adversely affect the food chains and other key elements of the Gulf ecosystem (Tucker & Associates, Inc., 1990). Because OCS discharges are diluted and dispersed in the offshore environment, impacts to cetaceans are expected to be negligible.

Helicopter activity projections are 110,000-410,000 trips over the life of a proposed action (Table 4-3) or 2,820-10,513 trips annually. The FAA Advisory Circular 91-36C encourages pilots to maintain higher than minimum altitudes (noted below) over noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. In addition, guidelines and regulations promulgated by NOAA Fisheries under the authority of the Marine Mammal Protection Act do include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 100 yd (91 m) of marine mammals. It is unlikely that cetaceans would be affected by routine OCS helicopter traffic operating at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. It is expected that about 10 percent of helicopter trips would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from, and interrupt cetaceans nearby (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences if they repeatedly disrupt vital functions, such as feeding and breeding. Frequent overflights are expected in coastal and Federal neritic waters. Generally, overflights are less frequent the further from shore the OCS facilities being serviced are located; however, many offshore fields are supported by resident helicopters that results in increased localized overflights. The area supported by a resident helicopter is dependent in part on the size of the field that it supports. Temporary disturbance to cetaceans may occur on occasion as helicopters approach or depart OCS facilities if animals are near the facility. Such disturbance is believed negligible.

An estimated 25,000-36,000 OCS-related, service-vessel trips are expected to occur over the life of a proposed action (Table 4-3). The rate of trips would be about 641-923 trips/yr. Noise from service-vessel traffic may elicit a startle and/or avoidance reaction from cetaceans or mask their sound reception. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity. Long-term displacement of animals from an area is also a consideration. It is not known whether toothed whales exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased ship traffic could increase the probability of collisions between ships and marine mammals, resulting in injury or death to some animals. Smaller delphinids may approach vessels that are in transit to bow-ride. Limited observations on an NMFS cruise off the mouth of the Mississippi River in the summer of 2000 indicated that sperm whales appeared to avoid passing service vessels. However, marine mammalogists conducting surveys in the CPA during the summer of 2001 documented an adult killer whale that bore conspicuous and aged scarring across its back that were indubitably the result of a collision with a motor vessel. A manatee was unintentionally hit and killed by a boat off Louisiana (Schiro et al., 1998). Another manatee was killed by vessel traffic (type of vessel unknown) in Corpus Christi Bay in October 2001 (Beaver, personal communication, 2001). It appears there is limited threat posed to smaller, coastal delphinids where the majority of OCS vessel traffic occurs. As exploration and development of petroleum resources in oceanic waters of the northern Gulf increases, OCS vessel activity will increase in these waters, thereby increasing the risk of vessel strike to sperm whales and other deep-diving cetaceans (e.g., *Kogia* and beaked whales). Deep-diving whales are more vulnerable to vessel strikes because of the extended surface period required to recover from extended deep dives. Manatees are rare in the western and central Gulf, consequently, there is little risk posed by OCS vessel traffic.

A total of 37-115 exploration wells and 97-166 development wells are projected to be drilled as a result of a proposed action (Table 4-3). A total of 11-15 production structures are projected to be installed as a result of a proposed action (Table 4-3). These wells and platforms could produce sounds at intensities and frequencies that could be heard by cetaceans. It is expected that noise from drilling activities would be relatively constant and last no longer than four months per well. Odontocetes echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms. Sound levels in this range are not expected to be generated by drilling operations (Gales, 1982). Bottlenose dolphins, one of the few species in which low-frequency sound detection has been studied, have been found to have poor sensitivity levels at the level where most OCS-industry noise energy is concentrated. There is some concern for baleen whales since they are apparently more dependent on low-frequency sounds than other marine mammals; however, except for the Bryde’s whale, baleen whales are extralimital or accidental in occurrence in the Gulf. During GulfCet surveys, Bryde’s whale was sighted only in the EPA; these sightings were in waters deeper than 100 m (Davis et al., 2000). Therefore, Bryde’s whale would not likely be subjected to OCS drilling and production noise. Potential effects on Gulf of Mexico marine mammals include disturbance (subtle changes in behavior, interruption of previous activities, or short- or long-term displacement); masking of calls from conspecifics, reverberations from own calls, and other natural sounds (e.g., surf, predators); stress (physiological); and hearing impairment (permanent or temporary) by explosions and strong nonexplosive sounds.

Potential impacts to marine mammals from the detonation of explosives include lethal and injurious incidental take, as well as physical or acoustic harassment. Injury to the lungs and intestines and/or auditory system could occur. Harassment of marine mammals as a result of a noninjurous physiological response to the explosion-generated shock wave as well as to the acoustic signature of the detonation is also possible. It is estimated that 5-7 production structures resulting from a proposed action would be removed using explosives (Table 4-3). It is expected that structure removals would cause only minor behavioral changes and noninjurious physiological effects on cetaceans as a result of the implementation of MMS guidelines and NOAA Fisheries Observer Program for explosive removals (Chapter 4.1.1.3.3). To date, there are no documented "takes" of marine mammals resulting from explosive removals of offshore structures.

Many types of materials, including plastics, are used during drilling and production operations. Some of this material is accidentally lost overboard where cetaceans can consume it. The result of ingesting some materials lost overboard could be lethal. The relationship between the occurrence of these waste products and the quantities ingested that produce a lethal effect are unknown.

Summary and Conclusion

Small numbers of marine mammals could be killed or injured by chance collision with service vessels and by eating indigestible debris, particularly plastic items, lost from service vessels, drilling rigs, and fixed and floating platforms. Deaths due to structure removals are not expected due to existing mitigation measures or those being developed for structures placed in oceanic waters. There is no conclusive evidence whether anthropogenic noise has or has not caused long-term displacements of, or reductions in, marine mammal populations. Contaminants in waste discharges and drilling muds might indirectly affect marine mammals through food-chain biomagnification, although the scope of effects and their magnitude are not known.

The routine activities of a proposed action is not expected to have long-term adverse effects on the size and productivity of any marine mammal species or population stock endemic to the northern Gulf of Mexico.

4.3.1.6. Impacts on Sea Turtles

The major impact-producing factors resulting from the routine activities associated with a proposed action that may affect loggerhead, Kemp's ridley, hawksbill, green, and leatherback turtles include water-quality degradation from operational discharges; noise from helicopter and vessel traffic, operating platforms, and drillships; vessel collisions; brightly-lit platforms; explosive platform removals; and OCS-related trash and debris.

Discharges

Produced waters, drill muds, and drill cuttings are routinely discharged into offshore marine waters and are regulated by USEPA NPDES permits. Most operational discharges, as regulated, are diluted and dispersed when released in offshore areas and are considered to have sublethal effects (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would seem to be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling muds or waste discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web (for further information on bioaccumulation, see Chapter 4.1.1.3.4). Sea turtles may bioaccumulate chemicals such as heavy metals that occur in drilling mud. This might ultimately reduce reproductive fitness in the turtles, an impact that the already diminished population(s) cannot tolerate. Samples from stranded turtles in the Gulf of Mexico carry high levels of organochlorides and heavy metals (Sis et al., 1993).

Noise

There are no systematic studies published of the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. However, it is assumed that aircraft noise could be heard by a sea turtle at or near the surface and cause the animal to alter its normal behavior pattern (Advanced Research Projects Agency, 1995). Noise from service-vessel traffic may elicit a startle reaction from sea turtles and produce a temporary sublethal stress (NRC, 1990). Startle reactions may result in increased surfacings, possibly causing an increase in risk of vessel collision. Reactions to aircraft or vessels, such as avoidance behavior, may disrupt normal activities, including feeding. Important habitat areas (e.g., feeding, mating, and nesting) may be avoided due to noise generated in the vicinity. There is no information regarding the consequences that these disturbances may have on sea turtles in the long term. If sound affects any prey species, impacts to sea turtles would depend on the extent that prey availability might be altered.

Drilling and production facilities produce an acoustically wide range of sounds at frequencies and intensities that could possibly be detected by turtles. Drilling noise from conventional metal-legged structures and semisubmersibles is not particularly intense and is strongest at low frequencies (Richardson et al., 1995). Sea turtle hearing sensitivity is not well studied. A few preliminary investigations using adult green, loggerhead, and Kemp's ridley turtles suggest that they are most sensitive to low-frequency sounds (Ridgway et al., 1969; Lenhardt et al., 1983; Moein Bartol et al., 1999). It has been suggested that sea turtles use acoustic signals from their environment as guideposts during migration and as a cue to identify their natal beaches (Lenhardt et al., 1983). Bone-conducted hearing appears to be a reception mechanism for at least some of the sea turtle species, with the skull and shell acting as receiving structures (Lenhardt et al., 1983).

Noise-induced stress has not been studied in sea turtles. Captive loggerhead and Kemp's ridley turtles exposed to brief, audio-frequency vibrations initially showed startle responses of slight head retraction and limb extension (Lenhardt et al., 1983). Sound-induced swimming has been observed for captive loggerheads and greens (O'Hara and Wilcox, 1990; Moein Bartol et al., 1993; Lenhardt, 1994). Some loggerheads exposed to low-frequency sounds responded by swimming towards the surface at the onset of the sound, presumably to lessen the effects of the transmissions (Lenhardt, 1994). Sea turtles have been seen to begin to noticeably increase their swimming in response to an operating seismic source at 166 dB re-1μPa-m (measurement of sound level in water) (McCauley et al., 2000). The MMS has almost completed a programmatic EA on G&G permit activities in the Gulf of Mexico (USDOI, MMS, in preparation). The EA includes a detailed description of the seismic surveying technologies, energy output, and operations; these descriptions are incorporated here by reference. An anecdotal observation of a free-ranging leatherback's response to the sound of a boat motor suggests that leatherbacks may be sensitive to low-frequency sounds, but the response could have been to mid- or high-frequency components of the sound (Advanced Research Projects Agency, 1995). The potential direct and indirect impacts of sound on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Low-frequency sound transmissions could potentially cause increased surfacing and avoidance from the area near the sound source (Lenhardt et al., 1983; O'Hara and Wilcox, 1990; McCauley et al., 2000). The potential for increased surfacing could place turtles at greater risk of vessel collisions and potentially greater vulnerability to natural predators.

Vessel Collisions

Data show that vessel traffic is one cause of sea turtle mortality in the Gulf (Lutcavage et al., 1997). Stranding data for the U.S. Gulf of Mexico and Atlantic coasts, Puerto Rico, and the U.S. Virgin Islands show that between 1986 and 1993 about 9 percent of living and dead stranded sea turtles had boat strike injuries (n=16, 102) (Lutcavage et al., 1997); however,vessel-related injuries were noted in 13 percent of stranded turtles examined from strandings in the Gulf of Mexico and on the Atlantic Coast during 1993 (Teas, 1994), but this figure includes those that may have been struck by boats post-mortem. In Florida, where coastal boating is popular, 18 percent of strandings documented between 1991 and 1993 were attributed to vessel collisions (Lutcavage et al., 1997). Large numbers of loggerheads and 5 to 50 Kemp's ridley turtles are estimated to be killed by vessel traffic per year in the U.S. (NRC, 1990; Lutcavage et al., 1997). Numbers of OCS-related vessel collisions with sea turtles offshore are unknown, but it is expected that some sea turtles will be impacted.

Brightly-lit Platforms

Brightly-lit, offshore drilling facilities present a potential danger to hatchlings (Owens, 1983). Hatchlings are known to be attracted to light (Raymond, 1984; Witherington and Martin, 1996; Witherington, 1997) and may orient toward lighted offshore structures (Chan and Liew, 1988). If this occurs, hatchling predation might increase dramatically since large birds and predatory fishes also congregate around structures (Owens, 1983; Witherington and Martin, 1996).

Structure Removals

Offshore structures serve as artificial reefs and are sometimes used by sea turtles (Gitschlag and Herczeg, 1994). The dominant species of turtle observed at explosive structure removals is the loggerhead, but leatherback, green, Kemp's ridley, and hawksbill have also been observed (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). Loggerheads may reside at specific offshore structures for extended periods of time (Rosman et al., 1987b; Gitschlag and Renaud, 1989). The probability of occupation by sea turtles increases with the age of the structures (Rosman et al., 1987b). Sea turtles probably use platforms as places to feed and rest. Offshore structures afford refuge from predators and stability in water currents, and loggerheads have been observed sleeping under platforms or beside support structures (Hastings et al., 1976; Rosman et al., 1987b; Gitschlag and Renaud, 1989). Only near the Chandeleur and Breton Islands were sea turtles positively associated with platforms (Lohoefener et al., 1989 and 1990).

Information about the effects of underwater explosions on sea turtles is limited. O'Keeffe and Young (1984) assumed that shock waves would injure the lungs and other organs containing gas, expected that ear drums of turtles would be sensitive, and suggested that smaller turtles would suffer greater injuries from the shock wave than larger turtles. The NMFS conducted several studies before and after an explosive platform removal to determine its effects on sea turtles in the immediate vicinity (Duronslet et al., 1986; Klima et al., 1988). Immediately after the explosion, turtles within 3,000 ft of the platform were rendered unconscious (Klima et al., 1988), although they resumed apparently normal activity 5-15 minutes post-explosion (Duronslet et al., 1986). One of these turtles also sustained damage to the cloacal lining (it was everted) (Klima et al., 1988). Dilation of epidermal capillaries was a condition that continued for three weeks, after which time all turtles appeared normal. Effects on their hearing were not determined. Impacts of explosive removals on sea turtles are not easily assessed, primarily because turtle behavior makes observations difficult. Sea turtles in temperate latitudes generally spend less than 10 percent of their time at the surface, and dive durations can exceed one hour. Injured turtles that are capable of swimming may return to the surface, while moribund turtles may sink to the seafloor or drift away from the work site. Unconsciousness renders a turtle more susceptible to predation; effects of submergence on stunned turtles is unknown (Klima et al., 1988). The number of documented sea turtles impacted by explosives is two loggerheads during 1986-1994 (Gitschlag and Herczeg, 1994; NRC, 1996), one loggerhead in 1997 (Gitschlag, personal communication, 1999), one loggerhead in 1998 (Shah, personal communication, 1998), and one loggerhead in 2001 (Gitschlag, personal communication, 2001). A total of six additional sea turtles have been captured prior to detonation of explosives and saved from possible injury or death (Gitschlag and Herczeg, 1994; Gitschlag et al., 1997). The low number of turtles affected by explosive removal of structures may be due to the few turtles that occur in harm's way at the time explosives are detonated, the effectiveness of the monitoring program established to protect sea turtles, and/or the inability to adequately assess and detect impacted animals.

In 1987, in response to 51 dead sea turtles that washed ashore on Texas beaches (explosions were identified as the primary cause by Klima et al., 1988), NMFS initiated an observer program at explosive removals of structures in State and Federal waters of the Gulf of Mexico. For at least 48 hours prior to detonation, NMFS observers watch for sea turtles at the surface. Helicopter surveys within a 1-mi radius of the removal site are conducted a minimum of 30 minutes prior to and after detonation (Gitschlag and Herczeg, 1994). If sea turtles are observed, detonations are delayed until the turtles have been safely removed or have left the area. Monitoring the water's surface for sea turtles is not 100 percent effective. Once observed, there is currently no practical and efficient means of removing a sea turtle from the area that will be impacted by explosives (Gitschlag and Herczeg, 1994). Although divers have had some success in capturing sea turtles, this procedure is limited to animals resting or sleeping beneath structures.

Even if turtles are not capable of hearing the acoustic properties of an explosion, physiological or behavioral responses (startle) to detonations may still result (USDOC, NMFS, 1995). Impacts resulting from resuspension of bottom sediments due to explosive detonation include increased water turbidity and mobilization of sediments containing hydrocarbon extraction waste (*Federal Register*, 1995a). Because of its temporary effect and localized nature, biomagnification is unlikely.

Jetsam and Flotsam

A wide variety of trash and debris is commonly observed in the Gulf. Marine trash and debris comes from a variety of land-based and ocean sources (Cottingham, 1988). Some material is accidentally lost during drilling and production operations. From March 1, 1994, to February 28, 1995, 40,580 debris items were collected in a 16-mi transect made along the Padre Island National Seashore (Miller et al., 1995). The offshore oil and gas industry was shown to contribute 13 percent of the trash and debris found in the transect. Turtles may become entangled in drifting debris and ingest fragments of synthetic materials (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988). Entanglement usually involves fishing line or netting (Balazs, 1985). Once entangled, turtles may drown, incur impairment to forage or avoid predators, sustain wounds and infections from the abrasive or cutting action of attached debris, or exhibit altered behavior that threaten their survival (Laist, 1987). Both entanglement and ingestion have caused the death or serious injury of individual sea turtles (Balazs, 1985). Balazs (1985) compiled dozens of records of sea turtle entanglement, ingestion, and impaction of the alimentary canal by ingested plastics, although tar was the most common item ingested. The marked tendency of leatherbacks to ingest plastic has been attributed to misidentification of the translucent films as jellyfish. Lutz (1990) concluded that turtles will actively seek out and consume plastic sheeting. Ingested debris may block the digestive tract or remain in the stomach for extended periods, thereby lessening the feeding drive, causing ulcerations and injury to the stomach lining, or perhaps even providing a source of toxic chemicals (Laist, 1987). Weakened animals are then more susceptible to predators and disease; they are also less fit to migrate, breed, or nest successfully.

The initial life history of sea turtles involves the hatching of eggs, evacuation of nests, and commencement of an open ocean voyage. Some hatchlings spend their “lost years” in sargassum rafts; ocean currents concentrate or trap floating debris in sargassum (Carr, 1987). Witherington (1994) studied post-hatchling loggerheads in drift lines 8-35 nmi east of Cape Canaveral and Sebastian Inlet, Florida. Out of 103 turtles captured, 17 percent of the animals contained plastic or other synthetic fibers in their stomachs or mouths. The Gulf of Mexico had the second highest number of turtle strandings affected by debris (35.9%) (Witzell and Teas, 1994). Although the Kemp’s ridley is the second most commonly stranded turtle, they are apparently less susceptible to the adverse impacts of debris than the other turtle species for some unknown reason (Witzell and Teas, 1994). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458) prohibits the disposal of any plastics at sea or in coastal waters.

Proposed Action Analysis

Information on drilling fluids, drill cuttings, and produced waters that would be discharged offshore as a result of a proposed action is provided in Chapter 4.1.1.3.4. These effluents are routinely discharged into offshore marine waters and are regulated by the USEPA’s NPDES permits. Turtles may be affected by these discharges. Very little information exists on the impact of drilling muds on Gulf sea turtles (Tucker and Associates, Inc., 1990).

Structure installation, pipeline placement, dredging, blowouts, and water quality degradation can impact seagrass bed and live-bottom sea turtle habitats. These impacts are analyzed in detail in Chapter 4.2.1.1. A discussion of the causes and magnitude of wetland loss as a result of a proposed action can be found in Chapter 4.2.1.1.2. The seagrass and high-salinity marsh components of wetland loss would be indirectly important for sea turtles by reducing the availability of forage species that rely on these sensitive habitats. Little or no damage is expected to the physical integrity, species diversity, or biological productivity of live-bottom marine turtle habitat as a result of a proposed action because these sensitive resources are protected by several mitigation measures established by MMS.

An estimated 25,000-36,000 OCS-related, service-vessel trips are expected to occur over the life of a proposed action (Table 4-3). The rate of trips would be about 641-923 trips/yr. Transportation corridors would be through areas where sea turtles have been sighted. Helicopter activity projections are 110,000-410,000 trips over the life of a proposed action (Table 4-3) or 2,820-10,513 trips annually. Noise from service-vessel traffic and helicopter overflights may elicit a startle reaction from sea turtles; there is the possibility of short-term disruption of activity patterns. Sounds from approaching aircraft are detected in the air far longer than in water. For example, an approaching Bell 214ST helicopter became audible in the air over four minutes before passing overhead, while it was detected underwater for only 38 seconds at 3-m depth and for 11 seconds at 18-m depth (Greene, 1985 *in* Richardson et al., 1995). There are no systematic studies published concerning the reactions of sea turtles to aircraft overflights, and anecdotal reports are scarce. It is assumed that aircraft noise could be heard by a sea turtle at or near the surface and cause it to alter its activity (Advanced Research Projects Agency, 1995). In the wild, most sea turtles spend at least 3-6 percent of their time at the surface. Despite the brevity of their respiratory phases, sea turtles sometimes spend as much as 19-26 percent of their time at the surface, engaged in surface basking, feeding, orientation, and mating (Lutcavage et al., 1997). Sea turtles located in shallower waters have shorter surface intervals, whereas turtles occurring in deeper waters have longer surface intervals. It is not known whether turtles exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased vessel traffic will increase the probability of collisions between vessels and turtles, potentially resulting in injury or death to some animals.

A total of 37-115 exploratory wells and 97-166 development wells are projected to be drilled as a result of a proposed action (Table 4-3). A total of 11-15 production structures are projected as a result of a proposed action (Table 4-3). These structures could generate sounds at intensities and frequencies that could be heard by turtles. There is some evidence suggesting that turtles may be receptive to low-frequency sounds, which is at the level where most industrial noise energy is concentrated. Potential effects on turtles include disturbance (subtle changes in behavior, interruption of activity), masking of other sounds (e.g., surf, predators, vessels), and stress (physiological).

It is estimated that 5-7 production structures would be removed by explosives as a result of a proposed action (Table 4-3). Potential impacts to sea turtles from the detonation of explosives include death, injury, stress, and physical or acoustic harassment. Injury to the lungs and intestines, and/or auditory system could occur. It is expected that structure removals would cause chiefly sublethal effects on sea turtles as a result of MMS guidelines for explosive removals (Chapter 4.1.1.3.3). Since 1986 when explosive removals were identified as a potential source of "take" of sea turtles, there have been only five documented "takes" of loggerhead sea turtles attributed to explosive removals.

Sea turtles can become entangled in or ingest debris produced by exploration and production activities resulting from a proposed action. Leatherback turtles that mistake plastics for jellyfish may be more vulnerable to gastrointestinal blockage than other sea turtle species. The probability of plastic ingestion/entanglement is unknown.

Summary and Conclusion

Routine activities resulting from a proposed action have the potential to harm sea turtles. These animals could be impacted by the degradation of water quality resulting from operational discharges; noise generated by helicopter and vessel traffic, platforms, and drillships; brightly-lit platforms; explosive removals of offshore structures; vessel collisions; and jetsam and flotsam generated by service vessels and OCS facilities. Lethal effects are most likely to be from chance collisions with OCS service vessels and ingestion of plastic materials. "Takes" due to explosive removals are expected to be rare due to mitigation measures already established (e.g., NOAA Fisheries Observer Program) and in development. Most OCS activities are expected to have sublethal effects. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effects. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or fecundity, and result in either population declines; however, such declines are not expected. The routine activities of a proposed action are unlikely to have significant adverse effects on the size and recovery of any sea turtle species or population in the Gulf of Mexico.

4.3.1.7. Impacts on Coastal and Marine Birds

This section discusses the possible effects of a proposed action in the WPA on coastal and marine birds of the Gulf of Mexico and its contiguous waters and wetlands. Major, potential impact-producing factors for marine birds in the offshore environment include OCS-related helicopter and service-vessel traffic and noise, air emissions, degradation of water quality, habitat degradation, and discarded trash and debris from service-vessels and OCS structures. Any effects are especially grave for intensively managed populations. For example, endangered and threatened species may be harmed by any impact on viable reproductive population size or disturbance of a few key habitat factors.

Proposed Action Analysis

Noise

The transportation or exchange of supplies, materials, and personnel between coastal infrastructure and offshore oil and gas structures is accomplished with helicopters, aircraft, and boats and a variety of service vessels. It is projected that 110,000-410,000 helicopter flights related to a proposed action in the WPA would occur over the life of a proposed action; this is a rate of 2,750-10,250 annual helicopter trips. Service vessels would use selected nearshore and coastal (inland) navigation waterways, or corridors, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. It is projected that 25,000-36,000 service-vessel trips related to a proposed action in the WPA would occur in the life of a proposed action; this is a rate of 625-900 service-vessels trips annually.

Major concerns related to helicopter and service-vessel traffic are intense aversion, panic, and head injury following a bird's collision with helicopters or vessels. Disturbances from OCS-related helicopter or service-vessel traffic to coastal birds can result from the mechanical noise or physical presence (or wake) of the vehicle. The degree of disturbance exhibited by groups of coastal birds to the presence of air or vessel traffic is highly variable, depending upon the bird species in question, type of vehicle, altitude or distance of the vehicle, the frequency of occurrence of the disturbance, and the season. Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior. Disturbance can also lead to a permanent desertion of active nests or of critical or preferred habitat, which could contribute to the relocation of a species or group to less favorable areas or to a decline of species through reproductive failure resulting from nest abandonment. When birds are flushed prior to or during migration, the energy cost could be great enough that they might not reach their destination on schedule or they may be more susceptible to diseases (Anderson, 1995). Waterfowl are more overtly responsive to noise than other birds and seem particularly responsive to aircraft, possibly because aerial predators frequently harass them (Bowles, 1995). The FAA and corporate helicopter policy advise helicopters to maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Many undisturbed coastal areas and refuges provide preferred and/or critical habitat for feeding, resting (or staging), and nesting birds. The effect of low-flying aircraft within the vicinity of aggregations of birds on the ground or on the water typically results in mass disturbance and abandonment of the immediate area. However, pilots traditionally have taken great pride in not disturbing birds. Compliance to the specified minimum altitude requirements greatly reduces effects of aircraft disturbance on coastal and marine birds. Routine presence of aircraft at sufficiently high altitudes results in acclamation of birds to routine noise. As a result of inclement weather, about 10 percent of helicopter trips would occur at altitudes somewhat below the minimums listed above. Although these incidents are seconds in duration and sporadic in frequency, they can disrupt coastal bird behavior and, at worst, possibly result in habitat or nest abandonment. Birds in flight over water typically avoid helicopters. Low-flying aircraft may temporarily disrupt feeding or flight paths. Routine presence and low speeds of service vessels within inland and coastal waterways would diminish the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. Birds can lose eggs and young when predators attack nests after parents are flushed into flight by service-vessel noise.

Air Quality Degradation

Contamination of wildlife by air emissions can occur in three ways: inhalation, absorption, and ingestion. Inhalation is the most common mode of contamination for birds (Newman, 1980). The major effects of air pollution include direct mortality, debilitating injury, disease, physiological stress, anemia, hypocalcemic condition, bioaccumulation of air pollutants with associated decrease in resistance to debilitating factors, and population declines (Newman, 1979). Direct effects can be either acute, such as sudden mortality from hydrogen sulfide, or chronic, such as fluorosis from fluoride emissions. The magnitude of effect, acute or chronic, is a function of the pollutant, its ambient concentration, pathway of exposure, duration of exposure, and the age, sex, reproductive condition, nutritional status, and health of the animal at the time of exposure (Newman, 1980). For metals in air emissions, chemical composition as well as size of particulate compounds has been shown to influence the toxicity levels in animals. Particulate size affects retention time and clearance from and deposition in the respiratory tract (Newman, 1981).

Levels of sulfur oxide (mainly sulfur dioxide, SO_2) emissions from hydrocarbon combustion from OCS-related activities are of concern in relation to birds. Research specific to birds has elucidated both acute and chronic effects from SO_2 inhalation (Fedde and Kuhlmann, 1979; Okuyama et al., 1979). Due to their lack of tracheal submucosal glands, birds appear to have more tolerance for inhaled SO_2 than most mammals (Llacuna et al., 1993; Okuyama et al., 1979). This suggestion stems from laboratory investigations where the test subject was the domestic chicken and results from these studies are not necessarily applicable to wild bird species. Acute exposure of birds to 100 ppm SO_2 produced no alteration in heart rate, blood pressure, lung tidal volume, respiratory frequency, arterial blood gases, or blood pH.

Exposure to 100 ppm or less of SO_2 did not affect respiratory mucous secretion. Exposure to 1,000 ppm SO_2 caused mucus to increase and drip from the mouths of birds, but lungs appeared normal. Exposure to 5,000 ppm resulted in gross pathological changes in airways and lungs, and then death (Fedde and Kuhlmann, 1979). Chronic (two week) exposure of birds to three concentrations of SO_2 for 16 hr/day for various total periods showed a statistical change in 10 cellular characteristics and resulted in cellular changes characteristic of persistent bronchitis in 69 percent of the tests done (Okuyama et al., 1979).

The indirect effects of air emissions on wildlife include food web contamination and habitat degradation, as well as adverse synergistic effects of air emissions with natural and other manmade stresses. Air emissions can cause shifts in trophic structure that alter habitat structure and change local food supplies (Newman, 1980).

Air pollutants may cause a change in the distribution of certain bird species (e.g., Newman, 1977; Llacuna et al., 1993). Migratory bird species will avoid potentially suitable habitat in areas of heavy air pollution in favor of cleaner areas if available (Newman, 1979). The abundance and distribution of passerine birds, both active and sedentary, and migratory species, as well as nonpasserine and nonmigratory varieties, are also greatly affected by natural factors such as weather and food supply. Therefore, any reduction in the numbers of birds within a given locale does not have a diagnostic certainty pointing to air emissions (Newman, 1980).

Chapter 4.3.1.4 provides an analysis of the effects of a proposed action in the WPA on air quality. Emissions of pollutants into the atmosphere from the activities associated with a proposed action would have minimum effects on offshore and onshore air quality because of the prevailing atmospheric conditions, emission heights and rates, and pollutant concentrations. Estimated increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} would be less than 0.29, 0.03, and 0.01 micrograms/m^3, respectively, per modeled steady state concentrations. These concentrations are far below concentrations that could harm coastal and marine birds.

Water Quality Degradation

Chapter 4.3.1.3 provides an analysis of the effects of a proposed action in the WPA on water quality. Expected degradation of coastal and estuarine water quality resulting from of OCS-related discharges may affect coastal birds directly by means of acute or chronic toxic effects from ingestion or contact, or indirectly through the contamination of food sources. Operational discharges or runoff in the offshore environment could also affect seabirds (e.g., laughing gulls) that remain and feed in the vicinity of offshore OCS structures and platforms. These impacts could also be both direct and indirect.

Maintenance dredging operations remove several million cubic feet of material, resulting in localized impacts (primarily increased turbidity and resuspended contaminants) during the duration of the operations. Water clarity will decrease over time within navigation channels used for vessel operations and within pipeline canals due to continuous sediment influx from bank erosion, natural widening, and reintroduction of dredged material back into surrounding waters. A proposed action would result in very small incremental contribution to the need for channel maintenance. Coastal and marine birds that feed exclusively within these locations would likely experience chronic, sublethal physiological stress. Some coastal and marine birds would experience a decrease in viability and reproductive success that would be indistinguishable from natural population variations.

Habitat Degradation

The greatest negative impact to coastal and marine birds is loss or degradation of preferred or critical habitat. The extent of bird displacement resulting from habitat loss is highly variable between different species, based upon specific habitat requirements and availability of similar habitat in the area. Habitat requirements for most bird species are incompletely known. Generally, destruction of habitat from OCS pipeline landfalls and onshore construction displaces localized groups or populations of these species. As these birds move to undisturbed areas of similar habitat, their presence may augment habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space and food. Pipeline landfalls and terminals, and other onshore OCS-related construction, can destroy coastal bird feeding or nesting habitat and can displace coastal bird populations from affected areas. Onshore pipelines cross a wide variety of coastal environments, including freshwater marsh and canals, and can therefore affect certain species generally not associated with marine or estuarine systems. These include certain waders, marsh birds, shorebirds, and waterfowl.

The analysis of the potential impacts to coastal environments (Chapter 4.3.1.1) concludes that a proposed action in the WPA is not expected to adversely alter barrier beach configurations significantly beyond existing, ongoing impacts in very localized areas downdrift of artificially jettied and maintained channels. Initial adverse impacts and more secondary impacts of pipeline and navigation canals are the most significant OCS-related and proposed-action-related impacts to wetlands. Initial impacts are locally significant and largely limited to where OCS-related canals and channels pass through wetlands. Secondary impacts may have substantial, progressive, and cumulative adverse impacts to the hydrologic basin or subbasin in which they are found.

Debris

Coastal and marine birds are susceptible to entanglement in floating, submerged, and beached marine debris; specifically in plastics discarded from both offshore sources and land-derived litter and waste disposal (Heneman and the Center for Environmental Education, 1988). Studies in Florida reported that 80 percent of brown pelicans showed signs of injury from entanglement with fishing gear (Clapp and Buckley, 1984). In addition, seabirds ingest plastic particles and other marine debris more frequently than do any other taxon (Ryan, 1990). Interaction with plastic materials may lead to permanent injuries and death. Ingested debris may have three basic effects on seabirds: irritation and blockage of the digestive tract, impairment of foraging efficiency, and release of toxic chemicals (Ryan, 1990; Sileo et al., 1990a). Effects of plastic ingestion may last a lifetime and may include physical deterioration due to malnutrition; plastics often cause a distention of the stomach, thus preventing its contraction and simulating a sense of satiation (Ryan, 1988). Some birds also feed plastic debris to their young, which could reduce survival rates. The chemical toxicity of some plastics can be high, posing a hazard in addition to obstruction and impaction of the gut (Fry et al., 1987). Sileo et al. (1990b) found that the prevalence of ingested plastic found within the gut of examined birds varied greatly among species. Species that seldom regurgitate indigestible stomach contents are most prone to the aforementioned adverse effects (Ryan, 1990). Within the Gulf of Mexico, these include the phalaropes, petrels, storm petrels, and shearwaters. It is expected that coastal and marine birds will seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics, garbage, and other solid wastes at sea or in coastal waters, went into effect January 1, 1989, and is enforced by the USCG.

Summary and Conclusion

The majority of effects resulting from a proposed action in the WPA on endangered/threatened and nonendangered/nonthreatened coastal and marine birds are expected to be sublethal: behavioral effects, sublethal exposure to or intake of OCS-related contaminants or discarded debris, temporary disturbances, and displacement of localized groups from impacted habitats. Chronic sublethal stress, however, is often undetectable in birds. As a result of stress, individuals may weaken, facilitating infection and disease; then migratory species may not have the strength to reach their destination. No significant habitat impacts are expected to occur directly from routine activities resulting from a proposed action. Secondary impacts to coastal habitats will occur over the long-term and may ultimately displace species from traditional sites to alternative sites.

4.3.1.8. Impacts on Fish Resources and Essential Fish Habitat

Effects on fish resources and essential fish habitat (EFH) from activities associated with a proposed action could result from coastal environmental degradation, marine environmental degradation, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters. Potential effects from routine activities resulting from a proposed action in the WPA on fish resources and EFH are described below. Potential effects on the three habitats of particular concern for Gulf of Mexico fish resources (the Flower Garden Banks National Marine Sanctuary, Weeks Bay National Estuarine Research Reserve in Alabama, and Grand Bay in Mississippi and Alabama) are included under the analyses for topographic features (Chapter 4.3.1.2.1) and wetlands (Chapter 4.3.1.1.2). Potential effects from accidental events (blowouts and spills) are described in Chapter 4.4.3.1.8. Potential effects on commercial fishing from a proposed action are described in Chapter 4.3.1.9.

Healthy fish resources and fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Because of the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for managed fish species in the WPA, the EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Since the majority of fish species within the WPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. The environmental deterioration and effects on EFH and fish resources result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries within Texas and Louisiana may be affected by activities resulting from a proposed action (Chapters 4.2.1.1.2, 4.3.1.1.2, and 4.4.3.1.2). These activities include construction of new onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (Chapters 4.3.1.3.1 and 4.4.3.3.1) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species within the WPA are dependent on offshore water and live bottoms, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH includes both high- and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Natural banks within the WPA are listed in Table 3-4. A detailed discussion of artificial reefs appears in Appendix 9.1.4. Three banks in the WPA are of particular importance; Stetson Bank and the East and West Flower Garden Banks now comprise the Flower Garden Banks National Marine Sanctuary and are considered EFH Habitat Areas of Particular Concern (HAPC). A proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Topographic Features Stipulation (Chapter 4.1.3.1) would prevent most of the potential impacts from a proposed action on topographic feature communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills.

Impact-producing factors from routine offshore activities that could result in marine water quality degradation include platform and pipeline installation, platform removal, and the discharge of operational wastes (Chapter 4.3.1.3.2). Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter offshore water quality (Chapter 4.4.3.3.2). Coastal operations could indirectly affect marine water quality through the migration of contaminated coastal waters (Chapter 4.3.1.3.1).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of production (Chapter 4.1.1.4). Seventy percent of the platforms in water depths less than 200 m are removed by severing their pilings with explosives placed 5 m below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991). Within the past decade, stocks of reef fish have declined in the Gulf. There is concern over a possible connection between this decline and the explosive removal of platforms. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA Fisheries and has investigated fish death associated with structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the Gulf of Mexico. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the Gulf of Mexico (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small and would not alter current determinations of status or current management recovery strategies.

Chronic, low-level pollution is a persistent and recurring event resulting in frequent but sublethal physiological irritation to fish resources that lie within the range of impact and that are likely to be adversely affected by the pollution. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question (in this case hydrocarbons).

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the discharge plume disperses rapidly, is very near background levels at a distance of 1,000 m, and is usually undetectable at distances greater than 3,000 m (Kennicutt, 1995) (Chapter 4.1.1.3.4.1). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds. There has recently been increased media focus on mercury uptake in fish and other marine species. An MMS-funded study titled *Gulf of Mexico Offshore Operations Monitoring Experiment* (Kennicutt, 1995) analyzed sediments at three sites in the GOM. Results of this study indicated that mercury levels were slightly elevated in sediments or organisms at one platform site (HI A-389). The average concentration of mercury at HI A-389 was twice as high as the other two platforms. The highest average concentration (0.41 ug/g) was found within 50 m of the platform but decreased to 0.12 ug/g at 100 m. Although these concentrations were the highest found, they were low relative to the probable effects level (0.7) believed to cause biological effects. This platform used the relatively rare practice of shunting drilling muds and cuttings to within 10 m of the seafloor to avoid dispersal and prevent impact to the nearby East Flower Garden Bank.

Metal concentrations were measured in tissues for 37 marine species. Fish tissue concentrations were generally low; for example, the average concentration was 0.45 ug/g for all flounder species, 0.39 ug/g all hake species, and 0.24 ug/g for all snapper species. Shrimp had statistically higher tissue concentrations (0.36 ug/g) near platforms than far (0.19 ug/g) from platforms. These values are well below the Federal guidelines set by FDA to protect human health, which is 1 ppm. Additional discussion of mercury in drilling muds can be found in Chapter 4.1.1.3.4.1.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m and are undetectable at a distance of 3,000 m from the discharge point (Harper, 1986; Rabalais et al., 1991; Kennicutt, 1995).

Proposed Action Analysis

The effects of a proposed action on coastal wetlands and coastal water quality, with the exception of accidental events, are analyzed in detail in Chapters 4.3.1.1.2 and 4.3.1.3.1, respectively. Collectively, the adverse impacts from these effects are called coastal environmental degradation in this EIS. The effects of a proposed action on offshore live bottoms and marine water quality are analyzed in detail in Chapters 4.3.1.2.1 and 4.3.1.3.2, respectively. Collectively, the adverse impacts from these effects are called marine environmental degradation in this EIS. The direct and/or indirect effects from coastal and marine environmental degradation on fish resources and EFH are summarized and considered below.

Coastal Environmental Degradation

A proposed action is projected to increase traffic in navigation channels to and from service bases in Texas and Louisiana. This may result in some erosion of wetlands along the channels, particularly in Louisiana. Additional information regarding erosion along navigation channels is provided in the wetland analysis (Chapters 4.3.1.1.2).

One new landfall is projected fin support of a proposed action. Depending on the site of this projected pipeline landfall, the activities associated with the installation could result in localized impacts to the coastal environment including degradation of water quality and potential erosion and loss of wetlands habitat.

Localized, minor degradation of coastal water quality is expected in waterbodies in the immediate vicinity of coastal shore bases, commercial waste-disposal facilities, and oil refineries or gas processing plants as a result of routine effluent discharges and runoff. A proposed action in the WPA is projected to contribute about 1 percent of the OCS-Program-related use of these facilities.

Maintenance dredging of waterways and channels would result in decreased water clarity and some resuspension of contaminants. This could preclude, in rare instances, uses of those waters directly affected by the dredging operations for up to several months. The periods between projected dredging operations, ranging from 1-2 years, should generally allow for the recovery of affected areas. Only a small amount of the routine dredging done in coastal areas will be directly or indirectly due to a proposed action.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH. Wetlands that could be impacted for some period of time or converted to open water are discussed in the wetlands analysis (Chapter 4.3.1.1.2). Recovery of fish resources or EFH can occur from more than 99 percent, but not all, of the potential coastal environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation and most EFH can recuperate quickly, but the loss of wetlands as EFH could be permanent. At the expected level of effect, the resultant influence on fish resources or EFH from a proposed action would be negligible and indistinguishable from natural population variations.

Marine Environmental Degradation

The Topographic Features Stipulation would prevent most of the potential impacts from a proposed action on topographic-feature communities (EFH) from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills resulting from a proposed action. For any activities associated with a proposed action, USEPA's Region 6 will regulate discharge requirements for the WPA through their NPDES permits. Contaminant levels in the WPA are generally low, reflecting the lack of pollution sources and high-energy environment of much of the region. The primary water quality impact from any increased turbidity would be decreased water clarity. Bottom disturbance from emplacement operations associated with a proposed action would produce localized, temporary increases in suspended sediment loading, resulting in decreased water clarity and little reintroduction of pollutants.

The major sources of discharges associated with a proposed action to marine waters are the temporary discharge of drilling muds and cuttings and the long-term discharge of produced-water effluent. Both of these discharges contain various contaminants of concern (e.g., trace metals and petroleum-based organic) that may have environmental consequences on marine water quality and aquatic life. Drilling mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than concentrations found a few meters from the discharge point. Offshore discharges of drilling muds are expected to dilute to background levels within 1,000 m of the discharge point.

Produced-water discharges contain components and properties potentially detrimental to fish resources. Moderate petroleum and metal contamination of sediments and the water column are expected to occur out to several hundred meters downcurrent from the discharge point (CSA, 1997a). Offshore discharges of produced water are expected to disperse and dilute to background levels within 1,000 m of the discharge point and amount to less than 1 percent of the annual harvest of surveyed commercial species.

The projected total number of platform installations resulting from a proposed action in the WPA is 11-15 for all water depths. Ten years after a platform is installed, the structure would be acting as an artificial reef. About 99 percent of the species present would be residents and not new transients from nearby live bottoms. All structures associated with a proposed action are expected to be removed by 2037. Structure removal results in artificial habitat loss and causes fish kills when explosives are used. Most multi-leg platforms in water depths less than 156 m are removed by severing their pilings with explosives placed 5 m below the seafloor. It is projected that 5-7 structures in water depths <200 m in the WPA will be removed using explosives as a result of a proposed action. It is expected that structure removals would have a negligible effect on fish resources because these activities kill only those fish proximate to the removal site.

The projected length of pipeline installations for a proposed action if 320-640 km. Trenching for pipeline burial has the potential to adversely affect fish resources. It is assumed that 5.02 m^2 of sediments per kilometer of pipeline would be resuspended during the installation of 160-320 km of pipelines in water depths less than 60 m. Where pipeline burial is necessary, a jetting sled is generally used. Water jets are directed downward to dig a trench and the apparatus can lay pipe at an average of 1.6 km/day (see Chapters 4.1.1.3.8.1 and 4.1.2.1.7 for additional discussion of pipelaying activities). Sandy sediments would be quickly redeposited within 400 m of the trench or blowout site, and finer sediments would be widely dispersed and redeposited within a few thousand meters over a period of 30 days or longer. Any affected population is expected to recover to predisturbance condition in one generation. At the expected level of impact, the resultant influence on fish resources would be negligible and indistinguishable from other natural population variations.

It is expected that marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of marine environmental degradation is expected to cause an undetectable decrease in fish populations. Recovery of fish resources or EFH can occur from 100 percent of the potential marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation. Offshore live bottoms are not expected to be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by USEPA NPDES permits. At the expected level of effect, the resultant influence on fish resources or EFH would be negligible and indistinguishable from natural population variations.

Summary and Conclusion

It is expected that coastal and marine environmental degradation from a proposed action would have little effect on fish resources or EFH. The impact of coastal and marine environmental degradation is expected to cause an undetectable decrease in fish resources or in EFH. Fish resources and EFH are expected to recover from more than 99 percent, but not all, of the expected coastal and marine environmental degradation. Fish populations, if left undisturbed, will regenerate in one generation, but any loss of wetlands as EFH would be permanent.

Offshore live bottoms will not be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by NPDES permits. At the expected level of impact, the resultant influence on fish resources and EFH would be negligible and indistinguishable from natural population variations.

Activities such as pipeline trenching and OCS discharge of drilling muds and produced water would cause negligible impacts and would not deleteriously affect fish resources or EFH. At the expected level of impact, the resultant influence on fish resources would cause less than a 1 percent change in fish populations or EFH. As a result, there would be little disturbance to fish resources or EFH.

A proposed action is expected to result in less than a 1 percent decrease in fish resources and/or standing stocks or in EFH. It would require one generation for fish resources to recover from 99 percent of the impacts. Recovery from the loss of wetlands habitat would probably not occur.

4.3.1.9. Impacts on Commercial Fisheries

Effects on commercial fishing from activities associated with a proposed action could result from installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, subsurface blowouts, pipeline trenching, and petroleum spills. The potential effects on fish resources and EFH from routine activities resulting from a proposed action in the WPA are described in Chapter 4.3.1.8. The potential effects from accidental events (blowouts and spills) are described in Chapter 4.4.3.10. The potential effects on commercial fishing from routine activities resulting from a proposed action are described below.

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for species in the WPA, the EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). Collectively, the adverse impacts on coastal EFH and marine EFH are called, respectively, coastal and marine environmental degradation in this analysis.

Since the majority of the commercial species harvested within the WPA are estuary dependent, coastal environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and commercial fisheries. Environmental deterioration and effects on EFH and commercial fisheries result from the loss of Gulf wetlands and coastal estuaries as nursery habitat and from the functional impairment of existing habitat through decreased water quality (Chambers, 1992; Stroud, 1992).

Wetlands and estuaries in Texas and Louisiana may be affected by activities resulting from a proposed action (Chapters 4.3.1.1.2 and 4.4.3.1.2). These activities include construction of new onshore facilities in wetland areas, pipeline emplacement in wetland areas, vessel usage of navigation channels and access canals, maintenance of navigation channels, inshore disposal of OCS-generated petroleum-field wastes, and spills from both coastal and offshore OCS-support activities.

Coastal water quality (Chapters 4.3.1.3.1 and 4.4.3.3.1) may be adversely affected by saltwater intrusion and sediment disturbances from channel maintenance dredging, onshore pipeline emplacements, and canal widening. Trash, discharges, runoff, and spills may be released from onshore facilities and vessel traffic. Besides coastal sources, offshore spills and trash occurring in association with OCS operations and reaching coastal waters may impact water quality conditions.

Since many of the fish species harvested within the WPA are dependent on offshore water and live bottoms, marine environmental degradation resulting from a proposed action, although indirect, has the potential to adversely affect EFH and fish resources. Offshore EFH includes both high-relief and low-relief live bottoms (pinnacles) and both natural (topographic features) and artificial reefs. Natural banks within the WPA are listed in Table 3-4. A detailed description of artificial reefs appears in Appendix 9.1.4. Three banks in the WPA are of particular importance. Stetson Bank and the East and West Flower Garden Banks now comprise the Flower Garden Banks National Marine Sanctuary and are also considered EFH Habitat Areas of Particular Concern (HAPC). Activities resulting from a proposed action could impact soft-bottom communities, hard-bottom communities (on high- and low-relief features), sand-bottom algal communities, and organisms colonizing scattered anthropogenic debris and artificial reefs. Impact-producing factors that could affect EFH include infrastructure emplacement, anchoring, infrastructure removal, operational offshore waste discharges, blowouts, and pipeline trenching. The impacts could include immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

The Topographic Features Stipulation (Chapter 2.4.1.3) would prevent most of the potential impacts from a proposed action on topographic-feature communities/EFH from bottom-disturbing activities (anchoring, structure emplacement and removal, and pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, and produced waters), blowouts, and offshore spills.

Impact-producing factors from routine offshore activities that could result in degradation of marine water quality include platform and pipeline installation, platform removal, and the discharge of operational wastes. Offshore accidents including blowouts and spills from platforms, service vessels, and pipelines could also occur and potentially alter offshore water quality (Chapter 4.4.3.3.2). Offshore water quality could also be impacted through migration of contaminated coastal waters (Chapter 4.4.3.3.1).

The area occupied by structures, anchor cables, and safety zones associated with a proposed action would be unavailable to commercial fishermen and could cause space-use conflicts. Exploratory drilling rigs would spend approximately 30-150 days onsite and would cause short-lived interference to commercial fishing. A bottom-founded, major production platform in shallow water, with a surrounding 100-m navigational safety zone, requires approximately 6 ha of space. A floating production system in deeper water requires as much as 5 ha of space. The use of FPSO's is not projected for a proposed action and the USCG has not yet determined what size of a navigational safety zone will be required for an FPSO during normal or offloading operations.

Underwater OCS obstructions, such as pipelines, can cause loss of trawls and catch, business downtime, and vessel damage. Pipelines in water depths less than 61 m (200 ft) are required to be buried, and their locations made public knowledge. Although Gulf fishermen are experiencing some economic loss from gear losses, the economic loss for a fiscal year has historically been less than 0.1 percent of the value of that same fiscal year's commercial fisheries landings. In addition, most financial losses from gear losses are covered by the Fishermen's Contingency Fund (FCF).

Lessees are required to remove all structures and underwater obstructions from their leases in the Federal OCS within one year of the lease relinquishment or termination of production (Chapter 4.1.1.4). Seventy percent of the platforms in water depths less than 200 m are removed by severing their pilings with explosives placed 5 m below the seafloor. The concussive force is lethal to fish that have internal air chambers (swim bladders), are demersal, or are in close association with the platform being removed (Gitschlag et al., 2000; Scarborough-Bull and Kendall, 1992; Young, 1991). Within the past decade, stocks of reef fish have declined in the Gulf. There is concern over a possible connection between this decline and the explosive removal of platforms. To examine this issue of concern, MMS entered into a formal Interagency Agreement with NOAA Fisheries and has investigated fish death associated with structure removal. This study reported the evaluation of fish deaths from platform removals related to the status of reef fish stocks in the Gulf of Mexico. Results indicated that the number of red snapper and other commercial species killed during explosive platform removals is less than 1 percent of the annual harvest of those species from the Gulf of Mexico (Gitschlag et al., 2000). One significant result determined that for red snapper, even when mortality estimates were doubled, impacts were estimated to be small, and would not alter current determinations of status or current management recovery strategies.

Chronic, low-level pollution is a persistent condition, resulting in frequent but sublethal physiological irritation to those resources that lie within the range of impact and that are likely to be adversely affected. The geographic range of the effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource.

Drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources; however, the plume disperses rapidly, is very near background levels at a distance of 1,000 m, and is usually undetectable at distances greater than 3,000 m (Kennicutt, 1995) (Chapter 4.1.1.3.4.1). Since 1993, USEPA has required concentrations of mercury and cadmium to be less than or equal to 1 ppm and 3 ppm, respectively, in the stock barite used to make drilling muds.

In addition to toxic trace elements and hydrocarbons in produced waters, there are additional components and properties, such as hypersalinity and organic acids, that have a potential to adversely affect commercial fishery resources. Produced waters that are discharged offshore are diluted and dispersed to very near background levels at a distance of 1,000 m and are undetectable at a distance of 3,000 m from the discharge point (Harper, 1986; Rabalais et al., 1991; Kennicutt, 1995).

Proposed Action Analysis

Installation of offshore structures may cause space-use conflicts with commercial fishing activities. The total projected number of production structure installation for a proposed action ranges from 11 to 15. Using the 100-m navigational safety zone figure (although to date very few operators have elected to apply to the USCG for a safety zone around their production platforms), the possible area excluded from commercial trawl fishing or longlining would range from 66 to 90 ha. The maximum excluded area represents only a very small fraction (0.0006%) of the total area of the WPA. All structures associated with a proposed action are projected to be removed by the year 2037.

In water depths less than 200 m, the area of concentrated bottom trawl fishing, 8-11 platforms would be installed under a proposed action, eliminating 48-66 ha from the area available for commercial fishing. There is no use of FPSO's projected for a proposed action. It is assumed that space-use conflicts will seldom occur. The effect of space loss to trawl fishing resulting from the construction of platforms in support of a proposed action in the WPA would be negligible; the maximum extent of the area lost to commercial trawling would be less than 0.01 percent of the available trawl fishing area in water depths less than 200 m. Nearly 845, 000 km^2 in two areas in the northeastern CPA and the northwestern EPA have been closed by NOAA Fisheries to longline fishing (Chapter 3.3.1 and Figure 3-9). The closure will displace commercial longlining and may increase activity in the WPA.

Underwater OCS obstructions such as pipelines may cause fishing gear loss and additional user conflicts. The area of concentrated bottom trawl fishing is in water depths less than 200 m. For a proposed action, it is projected that 157-314 km of pipeline associated with a proposed action will be installed in water depths less than 60 m; no projection of the length of installed pipelines has been made for water depths of 60-200 m. Gear loss and user conflicts are mitigated by the FCF. Direct payments for claims in FY 1997 totaled $238,404 and total payments for FY 1998 were $311,290. The amount available for Gulf of Mexico FCF claims in FY 1999 was $1,212,969. The majority of claims are resolved within six months of filing. The economic loss from gear loss and user conflicts has historically been less than 0.1 percent of the same year's value of Gulf commercial fisheries landings. It is assumed that installed pipelines will seldom conflict with bottom trawl or other fishing activities, and they are expected to have a negligible effect on commercial fishing.

Structure removals result in loss of artificial habitat and cause fish kills when explosives are used. It is projected that 5-7 structure removals using explosives will occur in water depths <200 m as a result of a proposed action. It is expected that structure removals will have a negligible effect on commercial fishing because of the inconsequential number of removals and the consideration that removals kill only those fish proximate to the removal site.

Seismic surveys will occur in both shallow and deepwater areas in the WPA. Usually, fishermen are precluded from a very small area for several days. This should not impact the annual landings or value of landings for commercial fisheries in the Gulf. Gulf of Mexico species can be found in many adjacent locations and Gulf commercial fishermen do not fish in one locale. Loss of fishing gear because of seismic surveys is also mitigated (see above) by the FCF. All seismic survey locations and schedules are published in the USCG *Local Notice to Mariners,* a free publication available to all fishermen. Seismic surveys will have a negligible effect on commercial fishing.

Summary and Conclusion

Activities such as seismic surveys, and pipeline trenching will cause negligible impacts and will not deleteriously affect commercial fishing activities. Operations such as production platform emplacement, underwater OCS impediments, and explosive platform removal, will cause slightly greater impacts on commercial fishing. At the expected level of impact, the resultant influence on commercial fishing will be indistinguishable from variations due to natural causes. As a result, there would be very little impact on commercial fishing. A proposed action is expected to result in less than a 1 percent change in activities, in pounds landed, or in the value of landings. It will require less than six months for fishing activity to recover from any impacts.

4.3.1.10. Impacts on Recreational Beaches

This section discusses the possible effects of a proposed action in the WPA on recreational beaches. Millions of annual visitors attracted to these resources are responsible for thousands of local jobs and billions of dollars in regional economic activity. Major recreational beaches are defined as those frequently visited sandy areas along the shoreline that are exposed to the Gulf of Mexico and that support a multiplicity of recreational activities, most of which is focused at the land and water interface. Included are Padre Island National Seashore, State parks and recreational areas, county and local parks, urban beaches, private resort areas, and State and private environmental preservation and conservation areas. The general locations of these beaches are indicated on MMS Visual 2 (Multiple Use; USDOI, MMS, 2001d).

The primary impact-producing factors to the enjoyment and use of recreational beaches are trash and debris, and oil spills. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation, and noise from OCS-related aircraft can adversely affect a beach-related recreation experience. All these factors, either individually or collectively, may adversely affect the number and value of recreational beach visits. The potential impacts from oil spills and other accidental events are discussed in Chapter 4.4.3.12.

The physical presence of platforms and drilling rigs visible from shore, and noise associated with vessels and aircraft traveling between coastal shore bases and offshore operation sites can adversely affect the natural ambience of primitive coastal beaches. Drilling rigs and platforms placed 3-10 mi from shore are within sight range of shoreline recreational beaches. Federal and State oil and gas operations are already occurring on nearshore tracts off Texas and Louisiana.

Although these factors may affect the quality of recreational experiences, they are unlikely to reduce the number of recreational visits to coastal beaches in the Central and Western Gulf.

Proposed Action Analysis

A proposed action in the WPA is projected to result in the drilling of 47-70 exploration and production wells and the installation of 6-8 platforms in water depths <60 m. In water depths of 60-200 m, a proposed action is projected to result in 16-34 wells and 1-2 platforms. Marine debris will be lost from time to time from OCS operations associated with drilling activities and production facilities projected to result from a proposed action in the WPA. Waste management practices and training programs are expected to minimize the level of accidental loss of solid wastes from activities resulting from a proposed action. Recreational beaches in Louisiana and Texas are most likely to be impacted by any waterborne trash. Beached litter and debris from a proposed action is unlikely to be perceptible to beach users or administrators because a proposed action would constitute only a small percentage (about 1%) of the total OCS Program activity in the WPA.

A proposed action is expected to result in 25,000-36,000 service-vessel trips over the life of the leases or about 625-900 trips annually. A proposed action is also expected to result in 110,000-410,000 helicopter trips, which is about 2,750-10,250 trips annually. Service vessels are assumed to use established nearshore traffic lanes and helicopters are assumed to comply with areal clearance restrictions at least 90 percent of the time. This additional helicopter and vessel traffic will add very little noise pollution likely to affect beach users.

Summary and Conclusion

Marine debris will be lost from time to time from operations resulting from a proposed action. The impact on Gulf Coast recreational beaches is expected to be minimal. The incremental increase in helicopter and vessel traffic is expected to add very little additional noise that may affect beach users. A proposed action is expected to result in nearshore operations that may adversely affect the enjoyment of some Gulf Coast beach uses; however, these will have little effect on the number of beach users.

4.3.1.11. Impacts on Archaeological Resources

Blocks with a high probability for the occurrence of prehistoric, prehistoric and historic, or historic archaeological resources are found in the Western Gulf. Blocks with a high probability for prehistoric archaeological resources are found landward of a line that roughly follows the last geologic still-stand before inundation at approximately 13,000 B.P. (years before present). This13,000-B.P. still-stand also roughly follows the 45-m bathymetric contour. Because of inherent uncertainties in both the depth of historic sea-level stands and the entry date of prehistoric man into North America, MMS has adopted the 12,000 B.P. and 60-m water depth as the seaward extent of the high-probability area for prehistoric archaeological resources.

The areas of the northern Gulf of Mexico that are considered to have a high probability for historic period shipwrecks were redefined as a result of an MMS-funded study (Garrison et al., 1989; LTL's dated November 30, 1990, and September 5, 1995). The study expanded the shipwreck database in the Gulf of Mexico from 1,500 to more than 4,000 wrecks. Statistical analysis of shipwreck location data identified two specific types of high-probability areas—the first within 10 km of the shoreline and the second proximal to historic ports, barrier islands, and other loss traps. High-probability search polygons associated with individual shipwrecks were created to afford protection to wrecks located outside the two aforementioned high-probability areas (cf. Visual 3, Offshore Regulatory Features; USDOI, MMS, 2001e). The historic archaeological high-probability areas are under MMS review at the time of this writing. NTL 98-06, issued August 10, 1998, supersedes all other archaeological NTL's and makes minor technical amendments, updates cited regulatory authorities, and continues to mandates a 50-m remote-sensing, survey linespacing density for historic shipwreck surveys in water depth of 200 m or less. The NTL also requires submission of an increased amount of magnetometer data to facilitate MMS analysis. Survey and report requirements for prehistoric sites have not been changed.

An Archaeological Resources Stipulation was included in all Gulf of Mexico lease sales from 1974 through 1994. The stipulation was incorporated into operational regulations at 30 CFR 250.26 with few changes, and all protective measures offered in the stipulation have been adopted in the regulation.

Additional supportive material for the archaeological resources analysis is provided in Chapters 3.3.2 (Description of the Affected Environment), and Chapters 4.2.1.13, 4.3.1.1.11, 4.4.3.13, and 4.5.13 (Environmental Consequences).

Several OCS-related, impact-producing factors may cause adverse impacts to archaeological resources. Offshore development could result in a drilling rig, platform, pipeline, dredging activity or anchors having an impact on an historic shipwreck. Direct physical contact with a wreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the period from which the ship dates.

The placement of drilling rigs and production platforms has the potential to cause physical impact to prehistoric and/or historic archaeological resources. It is assumed that the standard rig in less than 750 m of water will directly disturb 1.5 ha of soft bottom; the average platform in less than 450 m of water, 2 ha. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

Pipeline placement has the potential to cause a physical impact to prehistoric and/or historic archaeological resources. Pipelines placed in water depths of less than 61 m must be buried. Burial depths of 1 m are required with the exception of shipping fairways and anchorage areas, where the requirements are 3.0 m and 4.6 m, respectively.

The dredging of new channels, as well as maintenance dredging of existing channels, has the potential to cause a physical impact to historic shipwrecks (Espey, Huston, & Associates, 1990a). There are many navigation channels that provide OCS access to onshore facilities; most are located in the Central Gulf.

Anchoring associated with platform and pipeline emplacement, as well as with service-vessel and shuttle-tanker activities, may also physically impact prehistoric and/or historic archaeological resources. It is assumed that during pipeline emplacement, an array of eight 20,000-lb anchors is continually repositioned around the pipe-laying barge.

Activities resulting from a proposed action will generate ferromagnetic structures and debris, which will tend to mask magnetic signatures of significant historic archaeological resources. The task of locating historic resources through an archaeological survey is, therefore, made more difficult as a result of leasing activity.

4.3.1.11.1. Historic Archaeological Resources

Proposed Action Analysis

The likely locations of archaeological sites cannot be delineated without first conducting a remote-sensing survey of the seabed and near-surface sediments. The MMS has issued regulations at 30 CFR 250.194, 250.203(b)(15), 250.203(o),. 250.204(b)(8)(v)(A), 250.204(s), and 250.1007(a)(5) that require OCS lessees and operators and applicants for pipeline rights-of-way to conduct an archaeological survey prior to proposed activities within areas determined to have a high probability for historic and/or prehistoric archaeological resources. Generally, in the western part of the WPA, where unconsolidated sediments are thick, it is likely that side-scan sonar will not detect shipwrecks buried beneath the mud. In this area, the effectiveness of the survey for detecting historic shipwrecks of composite and wooden construction would depend on the capability of a magnetometer to detect ferromagnetic masses of the size characteristically associated with shipwrecks. It is assumed that the required 50-m line spacing (as specified in NTL 2002-G01) is a highly effective survey methodology, allowing detection of approximately 90 percent of historic shipwrecks within the survey area. The survey would therefore reduce the potential for an impact to occur by an estimated 90 percent.

According to estimates presented in Table 4-5, 134-281 exploration, delineation, and development wells will be drilled and 11-15 production platforms will be installed in support of a proposed action. Of these, 63-104 exploration, delineation, and development wells will be drilled, and 7-9 platforms will be installed in water depths of 200 m or less, where the majority of blocks with a high probability for historic period shipwrecks are located. The location of any proposed activity within a lease that has a high probability for historic shipwrecks requires archaeological clearance prior to operations. Considering that the expanded database contains 615 historic period shipwrecks in the entire Western Gulf OCS, the probability of an OCS activity contacting and damaging a shipwreck is very low. If an oil and gas structure contacted a historic resource, however, there could be a loss of significant or unique archaeological information.

Because there is only a thin Holocene sediment veneer overlying an indurated Pleistocene surface in the eastern part of the WPA, shipwrecks are more likely to be detected by side-scan sonar; therefore, the 50-m survey linespacing is expected to be even more effective (95%) for reducing the potential for a direct physical contact between an impact-producing factor and a shipwreck in the eastern WPA. There is a very small possibility that a historic shipwreck could be impacted by OCS activities. Should such an impact occur, however, significant or unique archaeological information could be lost.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Sites already listed on the National Register of Historic Places and those considered eligible for the Register have already been evaluated as being able to make a unique or significant contribution to science. At present, unidentified historic sites may contain unique historic information and would have to be assessed after discovery to determine the importance of the data.

Onshore development could result in the direct physical contact between the construction of new onshore facilities or pipeline canals and previously unidentified historic sites. This direct physical contact with a historic site could cause physical damage to, or complete destruction of, information on the history of the region and the Nation. It is assumed that 1 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. Table 4-5 shows the projected coastal infrastructure related to OCS Program activities. Each facility projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There is, therefore, no expected impact to onshore historic sites in the WPA from onshore development.

Maintenance dredging in support of activities resulting from a proposed action has the potential to impact a historic shipwreck. For instance, maintenance dredging in the Port Mansfield Entrance Channel is believed to impact the *Santa Maria de Yciar*, which sank on April 29, 1554 (Espey, Huston & Associates, 1990a) and is expected to impact the *SS Mary*, which sank on November 30, 1876, in Aransas Pass (Espey, Huston & Associates, 1990b). Impacts from maintenance dredging can be attributed proportionally to the users of the navigation channels. The MMS assessment indicates that, under a proposed action, less than 1 percent of the ship traffic through the Port Mansfield Cut is related to OCS use. Therefore, the impact to the *Santa Maria de Yciar* and *SS Mary* directly attributable to traffic and maintenance dredging as a result of the OCS Program is negligible. While the specific example falls within onshore coastal Subarea TX-1, an area unlikely to be affected by activities resulting from a proposed action in the WPA, it serves to illustrate that the potential exists for historic shipwrecks to be impacted by dredging. As these shipwrecks are unique historic archaeological resources, maintenance dredging, in general, is responsible for impacts to historic shipwrecks. Proposed action activities represent < 1 percent of the usage of the major navigation channels for the Western.

The loss of ferromagnetic debris during exploration and production activities has the potential to mask the magnetic signatures of historic shipwrecks. Under a proposed action, it is expected that hundreds of tons of ferromagnetic debris will be lost overboard. It is expected that most ferromagnetic debris associated with OCS structures will be removed from the seafloor during site-clearance activities. Site clearance, however, takes place after the useful life of the structure is complete. It has been noted that such debris has the potential to be moved from the area of initial deposition as a result of trawling activities (Garrison et al., 1989). Also, no site-clearance activities are required for pipeline emplacement operations. Therefore, there remains the potential for masking the signatures of historic shipwrecks as a result of ferromagnetic debris from OCS oil and gas activities.

Since all platform locations within the high-probability areas for the occurrence of offshore historic and prehistoric archaeological resources are given archaeological clearance prior to setting the structure, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structure Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

The greatest potential impact to a historic archaeological resource as a result of a proposed action in the WPA would result from direct contact between an offshore activity (platform installation, drilling rig emplacement, and dredging or pipeline project) and a historic shipwreck. An MMS-funded study (Garrison et al., 1989) resulted in the redefinition of the high-probability areas for the location of historic period shipwrecks. An MMS review of the historic high-probability areas is occurring at the time of this writing. The NTL for archaeological resource surveys in the Gulf of Mexico Region, NTL 2002-G01, mandates a 50-m linespacing for remote-sensing surveys of leases within the high-probability areas for historic shipwreck.

Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks.

Maintenance dredging of navigation channels may result in impacts to historic shipwrecks; however, the percentage of OCS use of these channels under a proposed action is less than 1 percent.

Most other routine activities associated with a proposed action in the WPA are not expected to impact historic archaeological resources. It is conservatively assumed that 1 percent of the OCS Program's use of projected onshore facilities will occur in support of a proposed action (Table 4-8). It is expected that archaeological resources will be protected through review and approval processes of various Federal, State, and local agencies involved in permitting onshore activities.

Offshore oil and gas activities resulting from a proposed action could contact a shipwreck because of incomplete knowledge on the location of shipwrecks in the Gulf. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with a proposed action in the WPA are not expected to affect historic archaeological resources.

4.3.1.11.2. Prehistoric Archaeological Resources

Offshore development as a result of a proposed action could result in an interaction between a drilling rig, a platform, a pipeline, dredging, or anchors and an inundated prehistoric site. This direct physical contact with a site could destroy fragile artifacts or site features and could disturb artifact provenance and site stratigraphy. The result would be the loss of archaeological data on prehistoric migrations, settlement patterns, subsistence strategies, and archaeological contacts for North America, Central America, South America, and the Caribbean.

Proposed Action Analysis

According to projections presented in Table 4-3, under a proposed action, 63-104 exploration, delineation, and development wells will be drilled, and 11-15 production platforms will be installed as a result of a proposed action in the WPA. Analysis by MMS indicates there is no potential for the occurrence of prehistoric archaeological sites in water depths greater than 60 m. If only the area likely to contain prehistoric sites (shallower than 60 m) is considered, 47-70 exploration, delineation, and development wells and 6-8 production platforms are projected to be installed (Table 4-3). The limited amount of impact to the seafloor throughout the WPA, the required archaeological survey, and archaeological clearance are sufficient to assume a low potential for impacting a prehistoric archaeological site. Should such an impact occur, damage to or loss of significant or unique prehistoric archaeological information could occur.

Onshore prehistoric archaeological resources include sites, structures, and objects such as shell middens, earth middens, campsites, kill sites, tool manufacturing areas, ceremonial complexes, and earthworks. At present, unidentified onshore prehistoric sites would have to be assessed after discovery to determine the uniqueness or significance of the information that they contain. Sites already listed in the National Register of Historic Places and those considered eligible for the Register have already been evaluated as having the potential for making a unique or significant contribution to science. Of the unidentified coastal prehistoric sites that could be impacted by onshore development, some may contain unique information.

Onshore development as a result of a proposed action could result in direct physical contact between construction of new onshore facilities or a pipeline landfall and a previously unidentified prehistoric site. Direct physical contact with a prehistoric site could destroy fragile artifacts or site features and could disturb the site context. The result would be the loss of information on the prehistory of North America and the Gulf Coast region. It is assumed that 1 percent of the OCS Program's use of projected onshore facilities will occur as a result of a proposed action. Table 4-8 shows the projected coastal infrastructure related to OCS Program activities. Each facility projected to be constructed must receive approval from the pertinent Federal, State, county/parish, and/or community involved. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There should, therefore, be no impact to onshore WPA prehistoric sites from onshore development related to a proposed action.

Each platform location within the high-probability areas for the occurrence of historic and prehistoric archaeological resources requires archaeological clearance prior to setting the structure; therefore, removal of the structure should not result in any adverse impact to archaeological resources. This is consistent with the findings of the *Programmatic Environmental Assessment: Structural Removal Activities, Central and Western Gulf of Mexico Planning Areas* (USDOI, MMS, 1987).

Summary and Conclusion

Several impact-producing factors may threaten the prehistoric archaeological resources of the Western Gulf. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric site located on the continental shelf. The archaeological survey and archaeological clearance of sites required prior to an operator beginning oil and gas activities on a block are expected to be highly effective (90%) at identifying possible prehistoric sites. Since the survey and clearance provide a significant reduction in the potential for a damaging interaction between an impact-producing factor and a prehistoric site, there is a very small possibility of an OCS activity contacting a prehistoric site. Should such contact occur, there would be damage to or loss of significant or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact from new facility construction, pipeline trenching, and new navigation canal dredging. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes of the Federal, State, and local agencies involved.

A proposed action in the WPA is not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost.

4.3.1.12. Impacts on Human Resources and Land Use

This proposed action analysis considers the effects of OCS-related, impact producing activities from a proposed WPA lease sale in relation to the continuing baseline of non-OCS-related factors. Non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity from State waters, wetland loss, and tropical storms. Unexpected events that may influence oil and gas activity within the analysis area but that cannot be predicted are not considered in this analysis.

4.3.1.12.1. Land Use and Coastal Infrastructure

Chapters 3.3.3.3 and 3.3.3.8 discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. The existing oil and gas infrastructure is expected to be sufficient to handle development associated with a proposed action. A proposed WPA lease sale would not alter the current land use of the area.

4.3.1.12.2. Demographics

In this section, MMS projects how and where future demographic changes will occur and whether they correlate with a proposed WPA lease sale. The addition of any new human activity, such as oil and gas development resulting from a proposed action, can affect local communities in a variety of ways. Typically, these effects are in the form of people and money, which can translate into changes in the local social and economic institutions and land use.

Proposed Action Analysis

Population

Population projections related to activities resulting from a proposed action are expressed as total population numbers and as a percentage of the population levels that would be expected if the proposed lease sale was not held (Tables 4-38 and 4-39). Chapter 3.3.3.4.1 discusses baseline population projections for the analysis area. Because the baseline projections assume the continuation of existing social, economic, and technological trends, they also include population changes associated with the continuation of current patterns in OCS Program activities. Population impacts from a proposed action in the WPA mirror the assumptions for employment impacts described in Chapter 4.3.1.12.3 below. Projected population changes reflect the number of people dependent on income from OCS related employment for their livelihood, which is based on the ratio of population to employment in the analysis area over the life of a proposed lease sale. Note that Subareas LA-1, LA-2, LA-3, and MA-1 correspond to the offshore CPA; TX-1 and TX-2 correspond to the WPA; and FL-1, FL-2, FL-3 and FL-4 correspond to the EPA.

Population associated with a proposed WPA lease sale is estimated at about 4,500-10,900 persons during the peak year of impact (year 10) for the low- and the high-case scenarios, respectively. While population associated with a typical WPA lease sale as proposed is projected to peak in year 10, years 7 and 11 also display close to peak levels of population. During the years of peak or near-peak population, a substantial amount of platform and pipeline installations are projected in association with a proposed WPA lease sale. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently, therefore leading to employment and population impacts.

Population impacts from a proposed action in the WPA are expected to be minimal, i.e., less than 1 percent of total population for any coastal subarea. The mix of males to females is expected to remain unchanged. The increase in employment is expected to be met primarily with the existing population and available labor force with the exception of some in-migration (some of whom may be foreign) projected to move into focal areas, such as Port Fourchon.

Age

If a proposed WPA lease sale is held, the age distribution of the analysis area is expected to remain virtually unchanged. Given both the low levels of population growth and industrial expansion associated with a proposed action, the age distribution pattern discussed in Chapter 3.3.3.4.2 is expected to continue through the year 2040. Activities relating to a proposed WPA Lease Sale are not expected to affect the analysis area's median age.

The population estimates in Table 4-38 reflects the diversity in the age of the residents in the urban region of the analysis area. Given both the projections of population growth and industrial expansion, this pattern is expected to continue into the year 2040 as well. Activities relating to a proposed WPA lease sale are not expected to affect the analysis area's median age.

Race and Ethnic Composition

The racial distribution of the analysis area is expected to remain virtually unchanged if a proposed WPA lease sale is held. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the racial distribution pattern described in Chapter 3.3.3.4.3 is expected to continue through the year 2040.

Education

Activities relating to a proposed WPA lease sale are not expected to significantly affect the analysis area's educational levels. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the analysis area's education status, described in Chapter 3.3.3.4.4, is expected to continue through the year 2040. Activities relating to a proposed WPA lease sale are not expected to affect the analysis area's educational attainment.

Summary and Conclusion

Activities relating to a proposed WPA lease sale are expected to minimally affect the analysis area's land use, infrastructure, and demography. These impacts are projected to mirror employment effects that are estimated to be negligible to any one subarea. Baseline patterns and distributions of these factors, as described in Chapter 3.3.3.3, are expected to maintain. Changes in land use throughout the analysis area are expected to be contained and minimal. The OCS-related infrastructure is in place and will not change as a result of a proposed action. Current baseline estimates of population growth for the analysis area show a continuation of growth, but at a slower rate.

4.3.1.12.3. Economic Factors

The importance of the oil and gas industry to the coastal communities of the Gulf of Mexico is significant, particularly in south Louisiana, eastern Texas, and coastal Alabama. Dramatic changes in the level of OCS oil and gas activity over recent years have resulted in parallel fluctuations in population, labor, and employment in the analysis area. The economic analysis for a proposed Lease Sale in the WPA focuses on the potential direct, indirect, and induced impacts of the OCS oil and gas industry on the population and employment of the counties and parishes in the analysis region defined in Chapter 3.3.3.1. To improve regional economic impact assessments and to make them more consistent with each other, MMS developed a new methodology for estimating changes to employment and other economic factors. The methodology developed to quantify these impacts on population and employment takes into account changes in OCS-related employment, along with population impacts resulting from these employment changes within each individual subarea.

The Gulf of Mexico region model has two steps.

(1) Because there are no publicly available models that estimate the expenditures resulting from offshore oil and gas activities, the model first estimates expenditures for 10 scenario activities projected to result from a proposed action in the WPA. These activities include exploratory drilling, development drilling, production operations and maintenance, platform fabrication and installation, pipeline construction, pipeline operations and maintenance, gas processing and storage construction, gas processing and storage operations and maintenance, workovers, and platform removal and abandonment. The model than assigns these expenditures to industrial sectors in the 10 subareas defined in Chapter 3.3.3.1.

(2) The second step in the model uses multipliers from the commercial input-output model IMPLAN (using 1999 data, the latest available data) to translate these expenditures into direct, indirect, and induced employment and other economic factors. Direct employment results from the first round of industry spending. It is the employment that results from the initial dollars spent by the oil and gas industry on the 10 scenario activities (listed above). Indirect employment results as the initial spending reverberates through the economy. First, the suppliers of the goods and services for the 10 activities spend the initial direct dollars from the industry. Then, these dollars are re-spent by other suppliers until the initial dollars have trickled throughout the economy. Households spending the resulting labor income creates induced employment.

Both the level (the amount spent) and the sectoral (the industry in which it is spent) allocation of expenditures can vary considerably by the phase of OCS activity and by the water depth of the OCS activities. For example, an exploratory well in 0-60 m of water is expected to be drilled using a jack-up rig and cost about $4 million, whereas an exploratory well in 800 m or greater water depth is expected to be drilled using a drillship and to cost in excess $10 million to complete. In addition, spending on materials such as steel will be much higher for platform fabrication and installation than for operations and maintenance once production begins. Therefore, the model estimates and allocates expenditures for ten scenario activities in four water-depth categories: 0-60 m, 61-200 m, 201-800 m, and >800 m). Because local economies vary, a separate set of IMPLAN multipliers is used for each coastal subarea to which expenditures are assigned. Each set of multipliers is based on the actual historical patterns of economic transactions in the area. Model results for employment are presented in the number of jobs per year, where one job is defined as a year of employment. This does not necessarily mean only one person occupies the position through out the year. One job may be equal to two part-time positions occupied over the year or one person occupying a position for 6 months, while another person occupies it for the other 6 months.

The projections in this section are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Because energy markets are complex, models are simplified representations of energy production and consumption, regulations, and producer and consumer behavior. Projections are highly dependent on the data, methodologies, model structures, and assumptions used in their development. Energy projections are subject to much uncertainty. Many of the events that shape energy markets are random and cannot be anticipated, including severe weather, political disruptions, strikes, and technological breakthroughs. In addition, future developments in technologies, demographics, and resources cannot be foreseen with any degree of certainty. Given this, MMS has endeavored to make these projections as objective, reliable, and useful as possible (USDOE, EIA, 2001b).

Proposed Action Analysis

Total employment projections for activities resulting from a proposed action are expressed as absolute numbers and as a percentage of the employment levels expected if no development occurs (Tables 4-40 and 4-41). Note that coastal Subareas TX-1 and TX-2 correspond to the offshore WPA; Subareas LA-1, LA-2, LA-3, and MA-1 correspond to the CPA; and Subareas FL-1, FL-2, FL-3 and FL-4 correspond to the EPA. The baseline projections of population and employment used in this analysis are described in Chapters 3.3.3.4 and 3.3.3.5 (Tables 3-12 to 3-27). Because these baseline projections assume the continuation of existing social, economic, and technological trends, they also include employment resulting from the continuation of current patterns in OCS Program activities. Population impacts, described in Chapter 4.3.1.12.2 (Table 4-40), mirror those assumptions associated with employment. Projected population changes reflect the number of people dependent on income from oil- and gas-related employment for their livelihood. This figure is based on the ratio of population to employment in the impact region over the life of a proposed lease sale.

Based on model results, direct employment associated with a proposed WPA Lease Sale is estimated at about 1,500-3,600 jobs during peak impact activity year 10 for the low- and high-case scenarios, respectively. Indirect employment is projected at about 500-1,300 jobs, while induced employment is calculated to be about 600-1,500 jobs for the low- and high-case scenarios, respectively. Therefore, total employment resulting from a proposed WPA lease sale is not expected to exceed 2,700-6,400 jobs in any given year over a proposed action's 40-year lifetime. While employment peaks in year 10 for the low- and high-case scenarios, years 7 and 11 also display close to peak levels of employment particularly for the low-case scenario. During these years, platform and pipeline installations are projected in association with a proposed WPA lease sale. Platform fabrication and installation, and pipeline installation activities are labor intensive and tend to occur concurrently.

Although most of the employment related to a proposed action is expected to occur in Subarea TX-2, employment is not expected to exceed 1 percent of the total employment in any given subarea of Texas, Louisiana, Mississippi, or Alabama (Table 4-41). On a percentage basis (percent of baseline employment), Subarea LA-1 depicts the greatest employment impact, with 0.2 percent of total employment from a proposed WPA lease sale. Considering Florida's current opposition to oil and gas development in offshore waters and the scarcity, if not absence, of onshore supporting service bases, MMS anticipates that very few OCS-related activities will be staged from Florida. Model results concur there would be little to no economic stimulus to the Florida analysis region as a result of a proposed WPA lease sale.

Summary and Conclusion

Should a proposed WPA lease sale occur, there would be only minor economic changes in the Texas, Louisiana, Mississippi, and Alabama subareas. A proposed action is expected to generate less than a 1 percent increase in employment in any of these subareas. This demand will be met primarily with the existing population and available labor force. There would be very little to no economic stimulus in the Florida subareas.

While a proposed WPA lease sale will not significantly impact the analysis area, OCS activities from past and future OCS lease sales will continue to occur and impact the analysis area. In other words, even if a proposed action were not held, there would still be impacts from past and future OCS lease sales on the analysis area. The OCS-related impacts will continue even in the absence of a proposed action. In addition, the lack of a proposed action would lead to reduced employment in affected sectors.

4.3.1.12.4. Environmental Justice

The analysis of environmental justice concerns is divided into those related to routine operations (below) and those related to oil spills (Chapter 4.4.3.14.2). Concerns related to routine operations center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). Chapter 3.3.3.5 describes the widespread presence of an extensive OCS support system and associated labor force, as well as economic factors related to OCS activities. The MMS estimates that production from a proposed action will be 0.136-0.262 BBO and 0.810-1.440 tcf of gas.

Proposed Action Analysis

Environmental justice issues involve questions of disproportionate and negative effects on minority and low-income populations. A proposed action in the WPA is expected to increase slightly employment opportunities in a wide range of businesses along the Gulf Coast. These conditions preclude a prediction of where much of this employment will occur or who will be hired. Figures 3-15 and 3-16 provide distributions of census tracts of high concentrations of minority groups and low-income households. As stated in Chapter 3.3.3.10, pockets of concentrations of these populations are scattered throughout the Gulf of Mexico coastal counties and parishes. Many of these populations are in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. Low-income populations are almost exclusively minority and urban. Because the distribution of low-income and minority populations does not parallel the distribution of industry activity, effects of a proposed action are not expected to be disproportionate.

The widespread economic effects of a proposed action on minority and low-income populations are not expected to be negative. Ongoing MMS research includes gathering information on race and employment. Offshore workers in the production sector are almost entirely male and white (Rosenberg, personal communication, 2001). Other sectors, such as the fabrication industry and support industries (e.g., trucking), employ minority workers and provide jobs across a wide range of pay levels and educational/skill requirements (Austin et al., 2002a and b; Donato et al., 1998). A study of oil industry trends between 1980 and 1990 found that downsizing was concentrated in the production sector; therefore, it affected white male employment more than that of women or minorities (Singelmann, in press). Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One MMS study in Louisiana found income inequality decreased during the oil boom and increased with the decline (Tolbert, 1995). Another MMS-funded study found that reemployment rates for poorly educated black and white women laid off in the closing of an OCS-related plant in one rural town were much higher than reemployment rates in similar closings elsewhere because Louisiana's oil industry had created a complex local economy (Tobin, 2001). While a proposed action will provide little additional employment, it will have the effect of maintaining current activity levels, which is expected to be beneficial to low-income and minority populations.

Environmental justice often concerns the possible siting of infrastructure in places that will have disproportionate and negative effects on minority and low-income populations. Since a proposed action will help to maintain ongoing levels of activity rather than expand them, no one proposed lease sale will generate significant new infrastructure demand. For this reason, this EIS considers infrastructure projections only for the cumulative analysis (Chapter 4.4.3.14.4). The cumulative analysis concludes that, as with the analysis of the employment effects of a proposed action, infrastructure effects are expected to be widely and thinly distributed. Since the siting of new infrastructure will reflect the distribution of the petroleum industry and not that of minority and low-income populations, the OCS activity in the WPA is not expected to disproportionately effect these populations. Again, Lafourche Parish is identified as a location of more concentrated effects. Each OCS-related facility constructed onshore must first receive approval by the relevant Federal, State, county or parish, and community involved, and MMS assumes that new construction will be approved only if consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms.

Because of Louisiana's extensive oil-related support system (Chapter 3.3.3.5.1) and because the configuration of the WPA makes much of the deepwater area of the WPA closer to coastal Louisiana than to coastal Texas, Louisiana is likely to experience more employment effects related to a proposed action in the WPA than are the other coastal states. Lafourche Parish, Louisiana, is likely to experience the greatest concentration and is the only parish where the additional OCS-related activities and employment are sufficiently concentrated to increase stress to its infrastructure. Even so, the effects of a proposed action are not expected to be significant in the long term. The concentrated socioeconomic impacts in Lafourche Parish are not expected to have disproportionate effects on minority and low-income populations for several reasons. The Parish is not predominately minority or low income (Figures 3-15 and 3-16). Existing information indicates that the Houma, a Native American tribe recognized by the State of Louisiana, are not expected to be disproportionately affected because they are not residentially segregated but, rather, live interspersed among the non-minority population (Fischer, 1970).

Two local infrastructure issues described in Chapter 3.3.3.2 could possibly have related environmental justice concerns—traffic on LA Hwy. 1 and the Port Fourchon expansion. Human settlement patterns in the area (on high ground along LA Hwy. 1 and Bayou Lafourche) mean that rich and low-income alike would be affected by any increased traffic. Port Fourchon is relatively new and is surrounded by mostly uninhabited land. Existing residential areas close to the port are also new and not considered low-income areas. Any expansion of infrastructure at Port Fourchon is not expected to disproportionately affect minority or low-income populations. Lafourche Parish is an area of relatively low unemployment because of the concentration of petroleum-related industry in the area (Hughes et al., in preparation). While the minority and low-income populations of Lafourche Parish will share with the rest of the parish population any negative impacts related to a proposed action in the WPA, most effects related to a proposed action would be economic and positive.

Summary and Conclusion

Because of the presence of an existing extensive and widespread support system for the OCS-related industry and associated labor force, the effects of a proposed action in the WPA are expected to be widely distributed and little felt. In general, who will be hired and where new infrastructure might be located is impossible to predict. Impacts related to a proposed action are expected to be economic and have a limited but positive effect on low-income and minority populations. Given the existing distribution of the industry and the limited concentrations of minority and low-income peoples, a proposed action sale is not expected to have a disproportionate effect on these populations. A proposed action is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people.

4.3.2. Alternative B — Proposed Action Excluding the Unleased Blocks Near Biologically Sensitive Topographic Features

Description of the Alternative

Alternative B differs from Alternative A (proposed action) by not offering the 61 unleased blocks of the 200 total blocks that are possibly affected by the proposed Topographic Features Stipulation (Chapter 2.4.1.3.1). All of the assumptions (including the two other potential mitigating measures) and estimates are the same as for a proposed action (Alternative A). A description of Alternative A is presented in Chapter 2.4.1.

The Federal offshore area is divided into subareas based on water depths in meters (W0-60, W60-200, W200-800, W800-1600, W1600-2400, and W>2400), and the adjacent coastal region is divided into two coastal subareas (TX-1 and TX-1). These subareas are delineated on Figure 4-1.

Effects of the Alternatives

The following analyses are based on the scenario for a proposed action in the WPA (Alternative A). The scenario provides assumptions and estimates on the amounts, locations, and timing for OCS exploration, development, and production operations and facilities, both offshore and onshore. A detailed discussion of the development scenario and major, related impact-producing factors is included in Chapter 4.1.1.

The analyses of impacts to the various resources under Alternative B are very similar to those for Alternative A. The reader should refer to the appropriate discussions under Alternative A for additional and more detailed information regarding impact-producing factors and their expected effects on the various resources. Impacts under Alternative B are expected to be the same as those under a typical proposed action in the WPA (Chapter 4.3.1) for the following resources:

–Sensitive Coastal Environments
–Sensitive Offshore Resources
  Deepwater Benthic Communities
–Water Quality
–Air Quality
–Marine Mammals
–Coastal and Marine Birds
–Commercial Fisheries
–Recreational Beaches
–Socioeconomic Conditions

The impacts to some Gulf of Mexico resources under Alternative B would be different from the impacts expected under a proposed action. These impacts are described below.

Impacts on Sensitive Offshore Resources

Topographic Features

The sources and severity of impacts associated with this alternative are those sale-related activities discussed for a proposed action. As noted in Chapter 4.3.1.2.1, the potential impact-producing factors to the topographic features of the Western Gulf are anchoring and structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. A more detailed discussion of these potential impact-producing factors is presented in that Chapter 4.3.1.2.1.

All of the 23 topographic features of the Western Gulf are located within water depths less than 200 m. These features occupy a very small portion of the entire area. Of the potential impact-producing factors to the topographic features, anchoring, structure emplacement, and structure removal will be eliminated by the adoption of this alternative. Effluent discharge and blowouts will not be a threat to the topographic features because blocks near enough to the banks for these events to have an impact on the biota of the banks will have been excluded from leasing under this alternative. Thus, the only impact-producing factor remaining from operations in blocks included in this alternative (i.e., those blocks not excluded by this alternative) is an oil spill. The potential impacts from oil spills are summarized below and are discussed further in Chapter 4.4.3.2.2.

A subsurface spill would have to come into contact with a biologically sensitive feature to have an impact. The chances of one or more subsurface pipeline spills ≥1,000 bbl in the Western Gulf is 17-30 percent. The chance of any amount of oil being released during a blowout is less than 10 percent. All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column. The fact that the topographic features are widely dispersed in the Western Gulf, combined with the random nature of spills, would serve to limit the likelihood of a spill occurring proximate to a topographic feature. Chapter 4.4.1.1.8 discusses the risk of spills interacting with topographic features, especially the Flower Garden Banks, in more detail. The currents that move around the banks are expected to steer any oil around the banks rather than directly upon them, lessening impact severity. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for most of the adult sessile biota. Lethal effects would probably be limited to a few coral colonies (as in the case of the Flower Garden Banks National Marine Sanctuary) (CSA, 1992b and 1994). It is anticipated that recovery from a mostly sublethal exposure would occur within a period of 2 years. In the unlikely event that oil from a subsurface spill could reach a coral-covered area (in the case of the Flower Garden Banks), the areal extent of coral mortality would be limited, but long-lasting sublethal effects may be incurred by organisms surviving the initial effects of a spill (Jackson et al., 1989). Indeed, the stress resulting from the oiling of reef coral colonies could affect their resilience to natural disturbances (e.g., elevated water temperature, diseases) and may hamper their ability to reproduce. A complete recovery of such an affected area could take in excess of 10 years.

Conclusion

Alternative B is expected to cause little or no damage to the physical integrity, species diversity, or biological productivity of the habitats of the topographic features. In the unlikely event that oil from a subsurface spill contacts the biota of a topographic feature, the effects would be localized and primarily sublethal for most of the adult sessile biota. Some lethal effects would probably occur upon oil contact to coral colonies (as in the case of the Flower Garden Banks National Marine Sanctuary); recovery from such an event is anticipated to occur within a period of 2 years.

Impacts on Sea Turtles

The level of activity associated with Alternative B is the same the infrastructure and activity described for a proposed action (Chapter 4.1 and Table 4-3). The sources and severity of impacts for sea turtles under Alternative B are the same as those under a proposed action (Chapter 4.3.1.6). The major impact-producing factors related to Alternative B that may affect Gulf sea turtles, including structure installation, dredging, operational discharges, and explosive platform removals, would not occur within the area excluded under Alternative B. The effects of these activities would occur in the remainder of the WPA and are expected to be primarily nonlethal, with few lethal impacts; the probability of an interaction is low.

Conclusion

Alternative B is expected to temporarily disturb some sea turtles and their habitats; however, it is unlikely to have significant long-term adverse effects on the size and productivity of any turtle species or population stock in the northern Gulf of Mexico.

4.3.3. Alternative C — No Action

Description of the Alternative

Alternative C is equivalent to cancellation of a sale scheduled for a specific period in the proposed *Outer Continental Shelf Oil and Gas Leasing Program: 2002-2007*. The OCS lease sales in the Western Gulf are scheduled on an annual basis. By canceling a proposed Western Gulf sale, the opportunity is postponed or foregone for development of the estimated 0.136-0.262 billion barrels of oil (BBO) and 0.810-1.440 trillion cubic feet (tcf) of gas.

Effects of the Alternative

Under Alternative C, the U.S. Dept. of the Interior cancels a planned Western Gulf of Mexico sale. Therefore, the oil expected from a sale will remain undiscovered and undeveloped. The environmental effects of Alternative A (proposed action) also would not occur. Energy from alternative sources for the lost production. Canceling a sale would eliminate the effects described for Alternative A (the proposed action). Other sources of energy would need to substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant environmental impacts of their own.

This section briefly discusses the most likely alternative sources, the quantities expected to be needed, and the environmental impacts associated with the alternatives. The discussion is based on material from the following MMS publications: *Proposed Final Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002, Decision Document* (USDOI, MMS, 1996a); *Outer Continental Shelf Oil and Gas Leasing Program: 1997-2002, Final Environmental Impact Statement* (USDOI, MMS, 1996b); and *Energy Alternatives and the Environment* (USDOI, MMS, 2001f). These sources are incorporated into this document by reference.

Most Important Substitutes for Production Lost Through No Lease Sale

Energy Alternatives and the Environment discusses a long list of potential alternatives to natural gas and oil. However, most substitutes for the natural gas and oil from a proposed action will come from four sources:

- additional imports;
- conservation;
- additional domestic production; and
- fuel switching.

Additional domestic production and imports will augment supply, while conservation and switching to alternative fuels shift demand downward. The table below shows the percentage and range of quantities expected to be needed to substitute for the lost natural gas and oil production. The quantities for conservation and fuel switching are in equivalent energy units.

Substitutes for Natural Gas and Oil Lost Because of No Lease Sale

Source	Percent of Lost Oil Production	Range of Oil Quantity (MMbbl)	Percent of Lost Gas Production	Range of Gas Quantity (Bcf)
Additional Imports	88%	134-385	12%	184-527
Conservation	5%	8-22	14%	214-615
Additional Domestic Production	4%	6-18	41%	627-1,800
Fuel Switching	3%	5-13	33%	505-1,449
Total Production Lost through No Sale	100%	153-438	100%	1,530-4,391

Environmental Impacts from the Most Important Substitutes

Additional Imports: Significant environmental impacts from an increase in oil imports include the following:

- generation of greenhouse gases and air pollutants from both transport and dockside activities (emissions of NO_x, SO_x, and VOC's have an impact on acid rain, tropospheric ozone formation, and stratospheric ozone depletion);

- degradation of water quality from oil spills related to accidental discharges or tanker casualties;
- oil-spill contact with flora, fauna, or recreational and scenic land and water areas; and
- increasing public concern about increasing imports of foreign oil and the potential for unauthorized interdiction or terrorist attacks on oil tankers.

Imported oil may also impose negative environmental impacts in producing countries and in countries along trade routes. Additional imports of natural gas would require construction of new pipelines from the most likely sources, which are Canada and Mexico. Pipeline construction can disrupt wildlife habitat, lead to increased erosion, and add to the siltation of streams and rivers.

Conservation: Conservation is composed of two major components:

- substituting energy-saving technology, often embodied in new capital equipment, for energy resources (e.g., adding to home insulation)
- consuming less of an energy-using service (e.g., turning down the thermostat in an office during the winter).

Consuming less of an energy service is positive from an environmental perspective. Substituting energy-saving technology will tend to result in positive net gains to the environment. The amount of gain will depend on the extent of negative impacts from capital equipment fabrication.

Additional Domestic Production: Onshore oil and gas production has notable negative impacts on surface water, groundwater, and wildlife. It can also cause negative impacts on soils, air pollution, vegetation, noise, and odor. Offshore oil and gas production imposes the risk of oil spills affecting water quality, localized degradation of air quality, potential impacts on coastal wetlands dependent wildlife, and shoreline erosion from additional supply boat traffic. Offshore activities may also have negative impacts on social, cultural, and economic measures such as recreation.

Fuel Switching: The most likely substitutes for natural gas are oil, which will further increase imports, and coal for use in electricity generation. Coal mining causes severe damage to land and wildlife habitat. It also is a major contributor to water quality deterioration through acid drainage and siltation. Alternative transportation fuels may constitute part of the oil substitution mix. The mix depends on future technical and economic advances. No single alternative fuel appears to have an advantage at this time. Every fuel alternative imposes its own environmental effects.

Other Substitutes

Government could also impose other substitutes for natural gas and oil. The most likely sectors to target would be transportation, electricity generation, or various chemical processes. *Energy Alternatives and the Environment* discusses many of the alternatives at a level of detail impossible here.

Summary and Conclusion

Canceling a sale would eliminate the effects described for Alternative A (Chapter 4.3.1). Other sources of energy would substitute for the lost production. Principal substitutes would be additional imports, conservation, additional domestic production, and switching to other fuels. These alternatives, except conservation, have significant environmental impacts of their own.

4.4. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTIONS—ACCIDENTAL EVENTS

4.4.1. Accidental Events

The National Environmental Policy Act (NEPA) requires Federal agencies to consider potential environmental impacts of proposed actions as part of agency planning and decisionmaking. The NEPA analyzes actions that could result in impacts, including actions that have a very low probability of occurrence, but that the public considers important, are controversial, or may have severe consequences. Accidental events that fall into this category and are addressed in this section are oil spills, blowouts, vessel collisions, and spills of chemicals or drilling fluids.

4.4.1.1. Oil Spills

Large oil spills associated with OCS activities are low-probability events. Public input through scoping meetings and Federal and State agencies' input through consultation and coordination indicate that oil spills continue to be a major issue. This section analyzes the risk of spills that could occur as a result of typical proposed actions in the CPA and WPA. Chapter 4.1.3.4 provides information on accidental spills that could result from all operations conducted under the OCS Program, as well as information on the number and sizes of spills from non-OCS sources.

4.4.1.1.1. Spill Prevention

Beginning in the 1980's, MMS has comprehensive pollution prevention requirements that include redundant safety systems, as well as inspection and testing requirements to confirm that these devices are working properly (Chapter 1.5). There was an 89 percent decline in the volume of oil spilled per billion barrels produced from OCS operations during 1980 through the present (8,211 bbl/Bbbl from facilities and 1,493 bbl/Bbbl from pipelines) compared to the total volume spilled per billion barrels prior to 1980 (45,897 bbl/Bbbl from facilities and 44,779 bbl/Bbbl from pipelines). This reduction in spill volume has occurred during a period when oil production has been increasing. The MMS attributes this improvement to MMS operational requirements, ongoing efforts by the oil and gas industry to enhance safety and pollution prevention, and the evolution and improvement of offshore technology.

4.4.1.1.2. Overview of Spill Risk Analysis

There are many factors that MMS evaluates to determine the risk of impact occurring from an oil spill. Information that can be quantitatively estimated include likely spill sources, likely spill sizes, the likelihood and frequency of occurrence for different size spills, timeframes for the persistence of spilled oil, volumes of oil lost due to weathering and cleanup, and the likelihood of transport by wind and waves resulting in contact to specified environmental features. Some factors cannot be quantified or projected. For example, the location and source of the spill; the characteristics of the spilled oil; the season and weather at the time of the spill; and the life stage, activities, biological abundance and locations of the species of concern. This section of the EIS addresses the likelihood of spill occurrence, transpiration of oil slicks by winds and waves, and the probability of an oil spill contacting sensitive environmental resources. Sensitivity of the environmental resources and potential effects are addressed in the analyses for the specific resources of concern (Chapter 4.4.3).

The MMS uses data on past OCS production and spills, along with estimates of future production, to evaluate the risk of future spills. Data on the numbers, types, sizes, and other information on past spills were reviewed to develop the spill scenario for analysis in this EIS. The spill scenario provides the set of assumptions and estimates on future spills; the type, frequency, quantity, and fate of the spilled oil for specific scenarios; and the rationale for the scenario assumptions or estimates. The spill scenario accounts for spill response and cleanup activities and the estimated time that the spill remains floating on the water.

The MMS uses two numerical models to calculate the likely trajectory and weathering of spills and analyzes the historical database to make other oil-spill projections. A description of the trajectory model, called the OSRA (oil spill risk analysis) model, and its results are summarized in this EIS and are published in a separate report (Ji et al., in preparation). The OSRA model simulates thousands of spills launched throughout the Gulf of Mexico OCS and calculates the probability of these spills being transported and contacting specified environmental resources. The OSRA modeling results in a numerical expression of risk based on spill rates, projected oil production, and trajectory modeling. The oil-weathering model used by MMS is considered to be state-of-the-art (Reed et al., 2000).

The following discussion provides separate risk information for offshore spills ≥1,000 bbl, offshore spills <1,000 bbl, and coastal spills that may result from the proposed actions.

4.4.1.1.3. Past OCS Spills

4.4.1.1.3.1. Offshore Spills

The MMS spill-event database includes records of past spills from activities that MMS regulates. These data include oil spills >1 bbl that occurred in Federal waters from OCS facilities and pipeline operations. Spills from facilities include spills from drilling rigs, drillships, and storage, processing, or production platforms that occurred during OCS drilling, development, and production operations. Spills from pipeline operations are those that have occurred on the OCS and are directly attributable to the transportation of OCS oil.

The MMS recently updated an analysis of trends in OCS spills (Anderson and LaBelle, 2000). Spill records for the most recent period analyzed, 1985-1999, were used to project future spill risk for this EIS. Data for this period reflect recent spill prevention and occurrence conditions. The 15-year record was chosen because it reflects how the spill rates have changed while still maintaining a significant portion of the record.

Table 4-20 presents oil spills for seven different spill-size groupings for the period 1985-1999. Data are provided on the total number of spills, number of spills by operation, total volume of oil spilled, and the spill rate calculated from data on historical spills and production. The average spill size and median spill size during this period are given for each spill-size category.

Tables 4-42 and 4-43 provide information on OCS oil spills ≥1,000 bbl that have occurred offshore in the Gulf of Mexico for the entire period that records have been kept (1964-2000). These data are divided into two groups based on whether the spills were from accidents associated with facility operations or pipeline transportation. The data show that there were no facility spills ≥1,000 bbl and eight pipeline spills ≥1,000 bbl during the period 1985-1999. The pipeline spills have been the result of damage caused by anchors, fishing trawls, and hurricanes.

The MMS data records do not include spills ≤1 bbl, but data on these small spills are available from the USCG Marine Safety Information System. Also not included in the MMS database are spills that have occurred in Federal waters from OCS barging operations and from other service vessels that support the OCS oil and gas industry. These data are included in the USCG record of all spills; however, the USCG database does not include the source of oil (OCS versus non-OCS) or in the case of spills from vessels, the type of vessel operations; such information is needed to determine if a particular spill occurred as a result of OCS operations.

4.4.1.1.3.2. Coastal Spills

Spills have occurred in coastal waters at shoreline storage, processing, or transport facilities supporting the OCS oil and gas industry. Coastal spills have occurred in State offshore waters and in navigation channels, rivers, and bays from barges and pipelines carrying OCS-produced oil. Records of spills in coastal waters and State offshore waters are maintained by the USCG (USDOT, Coast Guard, 2001a), but the database does not identify the source of the oil (OCS versus non-OCS). A pipeline carrying oil from a shore base to a refinery may be carrying oil stored from both State and OCS production; imported oil might also be commingled in the pipeline. The MMS does not maintain records on coastal spill events. Therefore, there is no database available that contains all past spills that have occurred in State offshore or coastal waters directly as a result of OCS oil and gas development. Information on past coastal spills that have occurred in the Gulf of Mexico area is found in Chapter 4.1.3.4.

4.4.1.1.4. Characteristics of OCS Oil

The physical and chemical properties of oil greatly affect how it will behave on the water surface (surface spills) or in the water column (subsea spills), the persistence of the slick on the water, the type and speed of weathering process, the degree and mechanisms of toxicity, the effectiveness of containment and recovery equipment, and the ultimate fate of the spill residues. Crude oils are a mixture of hundreds of different compounds. Hydrocarbons account for up to 98 percent of the total composition. The chemical composition of crude oil can vary significantly from different producing areas; thus, the exact composition of oil being produced in OCS waters varies throughout the Gulf.

The API gravity is a measurement of the density of the oil. The API gravity is calculated from the specific gravity; the lower the specific gravity, the higher the API gravity and the lighter the oil will be. Density is one of the most important physical characteristics of crude oil. The density of oil determines whether it will sink or float, whether it will collect sediment (heavier oils tend to collect sediment) and sink. The density of oil is one of the keys factors in predicting whether spilled oil will entrain water and form emulsions.

The API gravities of 91 plays are identified in the MMS 1995 National Assessment (Lore et al., 1999). The MMS data atlas presents an average of the many reservoirs contained in each play. Of the 91 plays represented, 67 plays had cumulative oil production greater than 100 Mbbl. A recently completed MMS study analyzed the API gravities (Trudel et al., 2001) of these 67 plays. The range of the average API gravities for these 67 plays was 22.8° -58.6°. Weighting the gravities by the relative oil production, all of the oils displayed API gravities in the 32 ° to 36 ° range, with an average of 33.9°. This represents a fairly light crude oil. Sorting the data by water depth indicates that oils become slightly heavier as water depths increase.

Water Depth	API Gravity
0-60 m	35°
61-200 m	34°
201-900 m	32°
>900 m	30°

It is expected that a typical oil spilled as a result of an accident associated with a proposed action would be within the range of 30° to 35° API. The oil at the light end of the range would have little asphaltenes, would not emulsify, and would not form tarballs. The oil at the heavier end of the range would more likely occur in deeper water; some emulsification and tarballs may occur with a spill of this heavier oil.

4.4.1.1.5. Risk Analysis for Offshore Spills ≥1,000 bbl

This section addresses the risk of spills ≥1,000 bbl that could occur from accidents associated with activities resulting from a proposed action.

4.4.1.1.5.1. Estimated Number of Offshore Spills ≥1,000 bbl and Probability of Occurrence

The number of spills ≥1,000 bbl estimated to occur as a result of a proposed action are provided in Table 4-44. The mean number of spills estimated for a proposed action in the WPA is less than one spill (mean equal to 0.21-0.40). The mean number of spills estimated for a proposed action in the CPA is one spill or less (mean equal to 0.42-0.99). The range of the mean number of spills reflects the range of oil production volume estimated as a result of a proposed action. The mean number of future spills ≥1,000 bbl is calculated by multiplying the spill rate for spills ≥1,000 bbl (1.51) by the volume of oil estimated to be produced as a result of a proposed action.

Figures 4-10 and 4-11 provide the probability of a particular number of offshore spills ≥1,000 bbl resulting from a proposed action during the 40-year analysis period.

For a proposed action in the CPA, there is a 27-37 percent chance of one spill ≥1,000 bbl occurring, a 6-18 percent chance of two spills ≥1,000 bbl occurring, a 1-6 percent chance of three spills ≥1,000 bbl occurring, and a <0.5-1 percent chance of four spills ≥1,000 bbl occurring. Overall, there is a 34-63 percent chance of one or more spills ≥1,000 bbl occurring.

For a proposed action in the WPA, there is a 17-27 percent chance of one spill ≥1,000 bbl occurring, a 2-5 percent chance of two spills ≥1,000 bbl occurring, and a <0.5-1 percent chance of three spills ≥1,000 bbl occurring. Overall, there is a 19-33 percent chance of one or more spills ≥1,000 bbl occurring.

Spill rates for all of the spill-size categories are provided in Table 4-20. Spill rates were calculated based on the assumption that spills occur in direct proportion to the volume of oil handled and are expressed as number of spills per billion barrels of oil handled.

A recently published paper by MMS authors provides more information on OCS spill-rate methodologies and trends (Anderson and LaBelle, 2000). A discussion of how the range of resource estimates was developed is provided in Chapter 4.1.1.1.

4.4.1.1.5.2. Most Likely Source of Offshore Spills ≥1,000 bbl

Figures 4-10 and 4-11 indicate the probabilities of one or more spills ≥1,000 bbl occurring from an OCS facility or pipeline in each OCS planning area. The data show that the most likely cause of a spill ≥1,000 bbl is a pipeline break at the seafloor.

Blowout events are often equated with catastrophic spills; however, in actuality very few blowout events have resulted in spilled oil, and the volumes spilled are often very small. Since 1998, three blowouts have resulted in oil spills with the amount of oil spilled ranging from <1 bbl to 200 bbl. Table 4-20 shows that there have been no spills ≥1,000 bbl from blowouts in the last 30 years.

4.4.1.1.5.3. Most Likely Size of an Offshore Spill ≥1,000 bbl

The median size of spills ≥1,000 bbl that occurred during 1985-1999 is 4,551 bbl and the median size for spills ≥10,000 bbl is 15,000 bbl (Table 4-20). Based on these median sizes, MMS estimates that the most likely size of a spill ≥1,000 bbl from a proposed action would be 4,600 bbl.

4.4.1.1.5.4. Fate of Offshore Spills ≥1,000 bbl

Persistence

The persistence of an offshore oil slick is strongly influenced by how rapidly it spreads and weathers and by the effectiveness of oil-spill response in removing the oil from the water surface.

As part of the risk analysis of an offshore spill ≥1,000 bbl, MMS estimated the expected persistence time of the spill, specifically, how long it might last as a cohesive mass on the surface of the water, capable of being tracked and moved by winds and currents. Tables 4-45 and 4-46 provide a mass balance over time for a likely spill related to a proposed action in each planning area. The MMS estimates that a spill ≥1,000 bbl with the characteristics and parameters specified in the table below would dissipate from the water surface in 2-10 days.

Spreading

Gulf of Mexico oils having API gravities between 30° and 35° will float, except under turbulent mixing conditions such as during a large storm offshore. Once spilled, it is expected that all Gulf of Mexico oils would rise and reach the surface of the open Gulf. On the sea surface, the oil would rapidly spread out on the water surface, forming a slick that is initially a few millimeters (mm) in thickness in the center and much thinner around the edges. The rate of spreading depends upon the viscosity of the spilled oil, whether or not the oil is released at the water surface or subsurface, and whether the spill is instantaneous or continuous for some period. The spilled oil would continue to spread until its thickest part is about 0.1 mm. Once it spreads thinner than 0.1 mm, the slick would begin to break up into small patches, forming a number of elongated slicks, with an even thinner sheen trailing behind each patch of oil.

Table 4-45 and 4-46 provides an estimate of the thickness and areal extent of a typical oil slick for different times after a spill event. If an offshore spill ≥1,000 bbl of oil having the properties and characteristics specified in the table below were to occur as a result of a proposed action and typical cleanup response was to take place, the slick would attain its greatest surface area by 12 hours after the spill event. The maximum water surface area covered by such a slick would be between 200 and 350 ac.

Weathering

Immediately upon being spilled, oil begins reacting with the environment. This process is called weathering. A number of processes alter the chemical and physical characteristics of the original hydrocarbon mixture, which reduces the oil mass over time. Weathering processes include evaporation of volatile hydrocarbons into the atmosphere, dissolution of soluble components, dispersion of oil droplets into the water column, emulsification and spreading of the slick on the surface of the water, chemo- or photo-oxidation of specific compounds creating new components that are often more soluble, and biodegradation. Weathering and the existing meteorological and oceanographic conditions determine the time that the oil remains on the surface of the water, and the characteristics of the oil at the time of contact with a particular resource also influence the persistence time of an oil slick. Oil-spill cleanup timing and effectiveness would also be determining factors.

Chemical, physical, and biological processes operate on spilled oil to change its hydrocarbon compounds, reducing many of the components until the slick can no longer continue as a cohesive mass floating on the surface of the water. By spreading out, the oil's more volatile components are exposed to the atmosphere and up to about two-thirds of the oil evaporates rapidly.

Over time, if the slick is not completely dissipated, a tar-like residue may be left; this residue breaks up into smaller tar lumps or tarballs that usually sink below the sea surface but not necessarily to the seafloor. Not all oils form tarballs; many Gulf of Mexico oils do not (Jefferies, 1979).

The MMS uses the SINTEF model to numerically model weathering processes to (1) estimate the likely amount of oil remaining on the ocean surface as a function time and (2) predict the composition of any remaining oil. Table 4-45 and 4-46 summarizes the model's results for a typical oil and the environmental scenarios in the WPA and CPA. Four scenarios were modeled. Information on the SINTEF model can be found in Daling et al. (1997) and Reed et al. (2000). The table below provides the scenario parameters used for the weathering model runs.

Input Parameters Used to Run Four Scenarios for Weathering Model

Parameter	Input
Spill Size	4,600 bbl
Duration of Spill	24 hours
API Gravity of Spilled 0il	Two oils: (1) 30^{o} API (Garden Banks 387) (2) 35^{o} API (Grand Isle)
Surface Water Temperature	Summer WPA & CPA 29 ^{o}C Winter WPA & CPA 20.2 ^{o}C
Mean Wind Speed	Summer WPA 5.3 m/s
	Winter WPA 7.2 m/s
	Summer CPA 4.0 m/s
	Winter CPA 7.2 m/s
Distance of Spill Source from Shore	200 m
Emulsification Formation	Yes for 30 ^{o} API oil No for 35 ^{o} API oil

The results of the weathering analyses are summarized in Tables 4-45 and 4-46. By 10 days after a spill event of $\geq$1,000 bbl, approximately 32-74 percent of the slick would have dissipated by natural weathering, between 30 and 32 percent would have been lost to the atmosphere via evaporation, and about 2-42 percent would have been lost into the water column via natural dispersion. The volume of the slick would be further reduced by spill-response efforts (Chapter 4.4.2.).

Seafloor Release

All evidence to date indicates that accidental oil discharges that occur at the seafloor (for example, from a blowout or a pipeline break) would rise in the water column, surfacing almost directly over the source location. All known reserves in the Gulf to date have specific gravities and chemical characteristics that would preclude oil slicks from sinking. Evidence from direct observation and remote imagery from space indicates oil slicks originating from natural seeps in the Gulf of Mexico occur on the sea surface almost directly above the known seep locations. Shipboard observations during submersible operations noted the surface expression of rising oil at a horizontal distance of 100 m from the origin of the seep on the bottom (MacDonald et al., 1995). A recent study in Norway, which intentionally released oil with chemical characteristics similar to Gulf of Mexico OCS oils at depth (844 m) and simulated blowout conditions, provided direct evidence that such an oil spill quickly rises to the surface. Within an hour after release, the oil appeared on the surface within a few hundred meters (horizontally) of the release site (Johansen et al., 2001).

4.4.1.1.5.5. Transport of Spills ≥1,000 bbl by Winds and Currents

Using the OSRA model, MMS estimates the likely trajectories of hypothetical offshore spills ≥1,000 bbl. The trajectories combined with estimated spill occurrence are used to estimate the risk of future spills occurring and contacting environmental features.

The OSRA model simulates the trajectory of a point launched from locations mapped onto a gridded area. The gridded area represents an area of the Gulf of Mexico, and the point's trajectory simulates a spill's movement on the surface of water using modeled ocean current and wind fields. The model uses temporally and spatially varying, numerically computed ocean currents and winds.

The OSRA model can simulate a large number of hypothetical trajectories from each launch point. Spill trajectories are launched once per day from each origin point and are time stepped every hour until a statistically valid number of simulations have been run to characterize the risk of contact. The simulated oil spills for this EIS were "launched" from approximately 4,000 points uniformly distributed 6-7 mi apart within the Gulf OCS. This spacing between launch points is sufficient to provide a resolution that created a statistically valid characterization of the entire area (Price et al., 2001).

The model tabulates the number of times that each trajectory moves across or touches a location (contact) occupied by polygons mapped on the gridded area. These polygons represent locations of various environmental features. The OSRA model compiles the number of contacts to each environmental feature that result from all of the modeled trajectory simulations from all of the launch points for a specific area. Contact occurs for offshore features if the trajectory simulation passes through the polygon. Contact occurs for land-based features if the trajectory simulation touches the border of the feature. The simulation stops when the trajectory contacts the lines representing the land/water boundary or the borders of the domain. The probability of contact to an environmental feature is calculated by dividing the number of contacts by the number of trajectories started at various launch locations in the gridded area.

The output from this component of the OSRA model provides information on the likely trajectory of a spill by wind and current transport, should one occur and persist for the time modeled in the simulations; the calculations for this EIS were modeled for 30 days. Because the analysis of the fate of a likely OCS spill (Chapter 4.4.1.1.5.4) showed that a slick would not persist on the water surface beyond 10 days, the OSRA model simulations were analyzed up to 10 days. All contacts that occurred during this period were tabulated.

A detailed description of the OSRA model used in this analysis is provided separately in a published report (Ji et al., in preparation). This report, including its figures and tables, will be available from the MMS Internet site (http://www.temporarygomr.com).

4.4.1.1.5.6. Length of Coastline Affected by Offshore Spills ≥1,000 bbl

Table 4-45 and 4-46 provides MMS's estimates of the length of shoreline that could be contacted if a typical spill ≥1,000 bbl occurred as a result of an accident associated with a proposed action. The length of shoreline contacted is dependent upon the original spill size and the volume of oil removed by natural weathering and offshore cleanup operations prior to the slick making shoreline contact. The shoreline length contacted is a simple arithmetic calculation based on the area of the remaining slick. The calculation assumes that the slick will be carried 30 m inshore of the shoreline, either onto the beachfront up from the water's edge or into the bays and estuaries, and will be spread out at uniform thickness of 1 mm; this assumes that no oil-spill boom is used. The maximum length of shoreline affected by a typical spill ≥1,000 bbl is estimated to be 30-50 km of shoreline, assuming such a spill were to reach land within 12 hours. Some redistribution of the oil due to longshore currents and further smearing of the slick from its original landfall could also occur.

4.4.1.1.5.7. Likelihood of an Offshore Spill ≥1,000 bbl Occurring and Contacting Modeled Locations of Environmental Resources

A more complete measure of spill risk was calculated by multiplying the probability of contact generated by the OSRA model by the probability of occurrence of one or more spills ≥1,000 bbl as a result of a proposed action. This provides a risk factor that represents the probability of a spill occurring as a result of a proposed action and contacting the resource of concern. These numbers are often referred to as "combined probabilities" because they combine the risk of occurrence of a spill from OCS sources and the risk of such a spill contacting sensitive environmental resources.

The combined probabilities are provided for each resource of concern in Figures 4-13 through 4-31. A discussion of spill risk to the resources is provided in Chapter 4.4.1.1.8.

To better reflect the geologic distribution of oil and gas resources and natural variances of meteorological and oceanographic conditions in the computation of combined probabilities, the MMS also generated combined probabilities for smaller areas within the WPA and CPA. The MMS used a cluster analysis to analyze the contact probabilities generated for each of the 4,000 launch points. For this analysis, similar trajectories and contact to 10-mi shoreline segments were used to identify offshore cluster areas. The estimated oil production from a proposed action was proportionally distributed to the cluster areas and the likelihood of spill occurrence was calculated for each cluster area. The probability of spill occurrence was combined with probabilities of contact from the trajectory modeling to estimate the combined risk of spills occurring and contacting various resources from spills in each cluster area. To account for the risk of spills occurring from the transportation of oil to shore, generalized pipeline corridors originating within each of the offshore cluster areas and terminating at major oil pipeline landfall areas were developed. The oil volume estimated to be produced as a result of a proposed action within each cluster area was proportioned among the pipeline corridors. The mean number of spills and the probability of contact of spills from each pipeline corridor were then calculated and combined with the risk of spills occurring and contacting resources from OCS facility development and production operations to complete the analysis.

4.4.1.1.5.8. Risk Analysis for Offshore Spills <1,000 bbl

The following section addresses the risk of spills <1,000 bbl resulting from a proposed action. To discuss spills <1,000 bbl, information is broken into size groups shown in Table 4-20.

Analysis of historical data show that most offshore OCS oil spills have been ≤1 bbl (Figure 4-12). Although spills of ≤1 bbl have made up 94 percent of all OCS-related spill occurrences; spills of this size have contributed very little (5%) to the total volume of OCS oil that has been spilled. Most of the total volume of OCS oil spilled (95%) has been from spills ≥10 bbl. For the period 1980-1999, OCS operators produced about 7.4 Bbbl of oil and the amount of OCS oil spilled offshore totaled about 71,500 bbl (less than 0.001%) or 1 bbl spilled for every 104,000 bbl oil and condensate produced.

For all spills ≥50 bbl, pipeline spills occurred the most frequently (60%). For all sizes of spills, facility spills have occurred more frequently than pipeline spills. For all spills >1 bbl since 1980, there have been 18 pipeline spills resulting in 60,718 bbl spilled and 55 facility spills resulting in 10,769 bbl spilled.

4.4.1.1.5.9. Estimated Number of Offshore Spills <1,000 bbl and Total Volume of Oil Spilled.

The number of spills <1,000 bbl estimated to occur over the next 40 years as a result of a proposed action is provided in Table 4-44. The number of spills is estimated by multiplying the oil-spill occurrence rate for each of the different size groups by the range of oil volumes estimated to be produced as a result of a proposed action. As spill size increases, the occurrence rate decreases and so the number of spills estimated to occur decreases.

The number of spills ≥500 bbl estimated to occur is less than one (mean number of spills equal to 0.07-0.14 for a WPA proposed action and 0.14-0.34 for a CPA proposed action).

The chance of one spill between 500 bbl and 1,000 bbl occurring is 6-12 percent for a WPA proposed action and 12-24 percent for a CPA proposed action.

Over the 40-year analysis period, 1-2 spills >50 bbl and <500 bbl are estimated to occur in the WPA from activities related to a proposed action, and 2-4 spills in this size category are estimated to occur in the CPA from activities related to a proposed action.

Multiplying the estimated number of spills by the median or average spill sizes for each size group yields the volume of oil estimated to be spilled by all spills <1,000 bbl as a result of a proposed action over the 40-year analysis period. A total of 500-1,600 bbl of oil is estimated from spills <1,000 bbl as a result of a proposed action in the WPA. A total of 1,000-2,900 bbl of oil is estimated from spills <1,000 bbl as a result of a proposed action in the CPA.

4.4.1.1.5.10. Most Likely Source and Type of Offshore Spills <1,000 bbl

Most spills <1,000 bbl would likely occur from a mishap on a production facility, most likely related to a failure related to storage of oil. Analysis of the 24 offshore oil spills >50 bbl and <1,000 bbl that occurred between 1985 and 1999 showed that 42 percent were diesel spills, 25 percent were condensate spills, and 21 percent were crude oil spills. The remaining spills were hydraulic fluids (2 spills) and diesel fuel or mineral oil-based drilling muds (2 spills). The most likely type of spill <1,000 bbl as a result of a proposed action is a diesel spill.

4.4.1.1.5.11. Most Likely Size of Offshore Spills <1,000 bbl

Table 4-44 provides the most likely volume of oil estimated to be spilled for each of the spill-size groups. These volumes represent the median spill size calculated for each category from MMS historical records (Table 4-20). During the 40-year analysis period, 97 percent of spills <1,000 bbl estimated to occur as a result of a proposed action would be ≤1 bbl.

4.4.1.1.5.12. Persistence, Spreading, and Weathering of Offshore Oil Spills <1,000 bbl

It is expected that slicks from spills <1,000 bbl will persist a few minutes (<1 bbl), a few hours (<10 bbl), or a few days (10-1,000 bbl) on the open ocean. Spilled oil would rapidly spread out, evaporate, and weather, quickly becoming dispersed into the water column. Most spills <1,000 bbl are expected to be diesel, which dissipates very rapidly. Diesel is a distillate of crude oil and does not contain the heavier components that contribute to crude oil's longer persistence in the environment.

4.4.1.1.5.13. Transport of Spills <1,000 bbl by Winds and Currents

To be transported by winds and currents, an oil slick must remain a drifting cohesive mass. Only spills >50 bbl have a chance of remaining a cohesive mass long enough to be transported any distance.

4.4.1.1.5.14. Likelihood of an Offshore Spill <1,000 bbl Occurring and Contacting Modeled Locations of Environmental Resources

Because spills <1,000 bbl are not expected to persist as a slick on the surface of the water beyond a few days and because spills on the OCS would occur at least 3 mi from shore, it is unlikely that any spills would make landfall prior to breaking up. For an offshore spill <1,000 bbl to make landfall, the spill would have to occur proximate to State waters (defined as 3-12 mi from shore). If a spill were to occur proximate to State waters, only a spill >50 bbl would be expected to have a chance of persisting long enough to reach land. Spills >50 bbl and <1,000 bbl size are very infrequent. Should such a spill occur, the volume that would make landfall would be expected to be extremely small (a few barrels). These assumptions are supported by a previous analysis of 3-day trajectory model runs, previous weathering analyses, and historical records of spill incidents.

4.4.1.1.6. Risk Analysis for Coastal Spills

Spills in coastal waters could occur at storage or processing facilities supporting the OCS oil and gas industry or from the transportation of OCS-produced oil through State offshore waters and along navigation channels, rivers, and through coastal bays. The MMS projects that almost all (>99%) oil produced as a result of a proposed action will be brought ashore via pipelines to oil pipeline shore bases, stored at these facilities, and eventually transferred via pipeline or barge to Gulf coastal refineries. Because oil is commingled at shore bases and cannot be directly attributed to a particular lease sale, this analysis of coastal spills addresses spills that could occur prior to the oil arriving at the initial shoreline facility. It is also possible that non-OCS oil may be commingled with OCS oil at these facilities or during subsequent secondary transport.

4.4.1.1.6.1. Estimated Number and Most Likely Sizes of Coastal Spills

The USCG Marine Safety Information System database of offshore and inland spills does not differentiate between spills associated with OCS and non-OCS activities. The MMS uses this database to estimate the number of coastal oil spills attributable to a proposed action by proportioning all spills occurring in the Gulf of Mexico coastal area by the volumes of oil handled by all oil-handling operations in the coastal area including OCS support operations, State oil and gas production, intra-Gulf transport, and coastal import/export oil activities. Chapter 4.1.3.4 provides more information on oil spills from these other operations.

From MMS's analysis of the USCG database for all spills in U.S. water and using assumptions to partition these spills to Gulf of Mexico OCS operations, Table 4-47 provides the number of spills by size group estimated to occur in coastal waters (both offshore State waters and coastal waters) during the 40-year analysis period as a result of each proposed action. The table provides an assumed spill size, derived from the USCG statistics, for each of the size groups. The MMS estimates that 25-50 spills in coastal waters are likely as a result of a typical sale in the WPA. Most of these spills would be ≤1 bbl (20-40 spills). One spill >50 bbl and <1,000 bbl could occur (assumed size 150 bbl)

For a typical sale in the CPA, the MMS estimates 55-125 spills during the 40-year analysis period, with 40-95 of these spills being ≤1 bbl. The MMS estimates that one spill ≥1,000 bbl (assumed size 3,000 bbl) and 1-2 spills >50 bbl and <1,000 bbl could occur (assumed size 150 bbl).

4.4.1.1.6.2. Likelihood of Coastal Spill Contact with Various Resources

The coastal spill rate is based on historical spills and the projected amount of oil production. For the purpose of this analysis, coastal spills are assumed to occur where oil production is brought to shore. Figure 4-32 shows major oil pipeline landfall areas and the projected percentages of oil production for a CPA proposed action and a WPA proposed action that will be brought to shore in these areas. Because the majority (70%) of oil production from a WPA proposed action is projected to be brought to shore in the Galveston/Houston/Texas City Area, it is assumed the majority of coastal spills from a WPA proposed action will also occur in this area. It is projected that the majority (95%) of oil production for a CPA proposed action will be brought to shore in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River. Based on this assumption the majority of coastal spills are projected to occur in this area, including one spill ≥1,000 bbl (assumed size 3,000 bbl) estimated to occur as the result of a CPA proposed action.

4.4.1.1.7. Risk Analysis by Resource

This section summarizes MMS's information on the risk to resources analyzed in this EIS from oil spills and oil slicks that could occur as a result of a proposed action in the WPA or CPA. The risk results are based on MMS's estimates of likely spill locations, sources, sizes, frequency of occurrence, physical fates of different types of oil slicks, and probable transport that are described in more detail in the preceding spill scenarios. This analysis presents combined probabilities, which include both the likelihood of a spill from a proposed action occurring and the likelihood of the oil slick reaching areas where known environmental resources occur. The analysis of the likelihood of direct exposure and interaction of a resource with an oil slick and the sensitivity of a resource to the oil is provided under each resource category in Chapter 4.4.3.

The term "oil spill" is a term that has several meanings. It may be used to describe the actual action of spilling oil. It is often used interchangeably with "oil slick." In this EIS, "oil spill" is used to describe an event that has a life history – it has a "birth" (the action of spilling) and is subjected to physical processes such as "aging" (weathering). Therefore, the oil spill can be described as undergoing life history stages, which include the following: slick formation, spreading, photolysis and evaporation, dissolution of water-soluble components, oil-in-water dispersion, adsorption to particles, microbiological degradation, vertical and horizontal diffusion, sedimentation, and resurfacing of larger oil droplets. Some of these stages are processes, while others describe the physical status of the spilled hydrocarbons.

Risk to sensitive environmental resources does not disappear when the "slick" disappears. After a slick disperses, hydrocarbons continue to persist in the sea for decades or longer. Marine organisms are exposed to these hydrocarbons in the waters where they reside, as well as through the prey that they consume. For example, FWS biologists from Texas recently commented to MMS that they are still finding tarballs, probably from the *Ixtoc* oil spill in Mexico that occurred decades ago, washing up on Padre Island National Seashore (PINS), a nesting beach for endangered Kemp's ridley sea turtles. Not far away is the Aransas National Wildlife Refuge, which is critical habitat to the endangered whooping crane. Sea turtle hatchlings that evacuate nests on PINS are at risk of ingesting or becoming fouled with these tarballs. Whooping cranes are also at risk of contact as they forage in estuarine and bay waters along the Coastal Bend region of Texas. During foraging forays, they may ingest or become fouled with tarballs. If parent birds become fouled by tarballs, they may subsequently foul the nest or their offspring. They may even feed their offspring prey contacted by tarballs.

Prior to washing up on beaches, tarballs persist in the sea. They may remain neutrally buoyant and suspended in the water column, or they may settle on the seafloor. Numerous marine organisms (including endangered and threatened cetaceans, manatees, and sea turtles) feed and ingest materials found in the water column or on the seafloor. These animals are at risk of ingesting oil or consuming prey contaminated or fouled by residual hydrocarbons introduced from an oil spill. The risk of exposure to marine protected species and their prey may last decades. The risk of exposure to tarballs or persistent hydrocarbons from an oil spill in the sea is less than the risk associated with exposure to an oil slick.

Analysis of Spill Risk to Sensitive Coastal Environments

Sensitive coastal environments located in the Gulf of Mexico consist primarily of coastal barrier beaches, wetlands, and seagrass communities (Chapter 3.2.1).

Risk from Offshore Spills ≥1,000 bbl

Because of the widespread distribution of sensitive coastal environments along the Gulf Coast, specific resource locations were not analyzed by the OSRA model trajectory simulations. The probabilities of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was used as an indicator of the risk of a slick from such a spill reaching sensitive coastal environments. Figure 4-13 shows the Gulf of Mexico coastal counties and parishes having a risk >0.5 percent of being contacted within 10 days by an offshore spill ≥1,000 bbl occurring as a result of a proposed action in the CPA or WPA. Most counties and parishes have a <0.5 percent probability of a spill ≥1,000 bbl occurring and contacting (combined probability) their shorelines within 10 days; five counties in Texas and six parishes in Louisiana have a 1-8 percent chance of an OCS offshore spill ≥1,000 bbl occurring and reaching their shoreline within 10 days. Plaquemines Parish, Louisiana, has the greatest risk (4-8%) of a spill occurring and contacting its shoreline within 10 days as a result of a CPA proposed action. In Texas, Matagorda County has the greatest risk (1-2%) of being contacted within 10 days by a spill occurring offshore as a result of a WPA proposed action.

Tables 4-45 and 4-46 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from Offshore Spills <1,000 bbl

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probability of occurrence.

Based on the assumption that spill occurrence is proportional to the volume of oil handled, sensitive coastal environments located near the coastal waters of the Galveston/Houston/Texas City area have the greatest risk of being contacted by coastal spills related to a proposed action in the WPA. A total of 70 percent of all oil estimated to be produced as a result of a proposed action in the WPA is projected to be to be brought into this area.

Sensitive coastal environments in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River, including Barataria Bay, have the greatest risk of being contacted by spills from operations related to a CPA proposed action. The greatest risk of contact would be from the assumed 3,000-bbl spill should it occur within or near wetlands.

Analysis of Spill Risk to Live Bottoms

The live bottoms (topographic features and pinnacle trend) sustaining sensitive benthic communities are listed and described in Chapters 4.2.1.2 and 4.3.1.2.

Risk from Offshore Spills

All evidence to date indicates that oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (Chapter 4.4.1.1.5.4). Therefore, a subsurface oil spill would have to occur very close to a topographic or pinnacle trend feature for the rising oil to contact the feature. There is a 16-25 percent chance that one pipeline spill ≥1,000 bbl would occur and a 1-5 percent chance that a second pipeline spill ≥1,000 bbl would occur as a result of a WPA proposed action. There is a 26-37 percent chance that one pipeline spill ≥1,000 bbl would occur, a 5-17 percent chance that a second pipeline spill ≥1,000 bbl would occur, and a 1-5 percent chance that a third pipeline spill ≥1,000 bbl would occur as a result of a CPA proposed action. For a proposed action in the WPA, 1-2 blowouts are estimated to occur during the 40-year analysis period; 2-4 blowouts are estimated to occur from a proposed action in the CPA. No pipeline spill or blowout would occur within 1,000 m of a topographic or pinnacle trend feature because lease stipulations prohibit drilling or pipeline emplacement within 1,000 m of identified live-bottom features.

Once the oil from a subsea spill reaches the sea surface, the slick behaves similarly to a slick from a surface spill. Oil from a surface slick can be driven into the water column. Measurable amounts have been documented down to a 10-m depth, and modeling exercises have indicated such oil may reach a depth of 20 m. As the crests of topographic and pinnacle trend features in the northern Gulf are primarily deeper than 20 m, with the exception of the features within the Flower Gardens Banks National Marine Sanctuary, oil from a surface spill is unlikely to reach the sessile biota of these live-bottom features.

The tops of the shallowest features in the Flower Gardens Banks National Marine Sanctuary are at approximately 15 m below sea level. If oil in a slick passing over the sanctuary were driven into the water column as deep as 15 m or more, biota in the sanctuary could be contacted. The likelihood of a surface slick from a spill associated with proposed action operations passing over the Sanctuary was calculated by the MMS's trajectory model. For proposed actions in the CPA and WPA, there is up to a 4 percent risk of an oil spill occurring and the surface slick passing over the Flower Garden Banks; there is up to 2 percent chance of a spill occurring and the surface slick passing over Stetson Bank.

Analysis of Spill Risk to Deepwater Benthic Communities

Deepwater benthic communities include both chemosynthetic and nonchemosynthetic communities (Chapter 3.2.3). Chemosynthetic communities occur in water depths of >400 m.

Risk from Offshore Spills

All evidence to date indicates that oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (Chapter 4.4.1.1.5.4). Therefore, a subsurface oil spill would have to occur very close to a benthic community for rising oil to contact the benthic organisms. There is a 16-25 percent chance that one pipeline spill ≥1,000 bbl would occur and a 1-5 percent chance that a second pipeline spill ≥1,000 bbl would occur as a result of a WPA proposed action. There is a 26-37 percent chance that one pipeline spill ≥1,000 bbl would occur, a 5-17 percent chance that a second pipeline spill ≥1,000 bbl would occur, and a 1-5 percent chance that a third pipeline spill ≥1,000 bbl would occur as a result of a CPA proposed action. For a proposed action in the WPA, 1-2 blowouts are estimated to occur during the 40-year analysis period; 2-4 blowouts are estimated to occur from a proposed action in the CPA. The likelihood that a pipeline spill or blowout would occur near a chemosynthetic community is extremely low, especially with consideration that NTL 2000-G20 prohibits drilling or pipeline emplacement within 1,500 ft of potential chemosynthetic communities.

The likelihood of weathered oil components from a surface slick reaching a deepwater chemosynthetic community in any measurable concentrations is very small.

Analysis of Spill Risk to Water Quality

The potential for spills to affect the quality of Gulf of Mexico coastal and marine waters is dependent on the frequency and volume of spills.

Risk from Offshore Spills

The MMS estimates that about 500-22,000 bbl of oil would be spilled in offshore waters over the 40-year life of a proposed action in the WPA and about 1,000-23,000 bbl of oil would be spilled in offshore waters over the 40-year life of a proposed action in the CPA. These volumes include volumes from spill incidents in all size groups.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probability of occurrence.

For offshore spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach coastal waters. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters. Should a slick from such a spill reach coastal waters, the volume of oil remaining in the slick is expected to be small.

Analysis of Spill Risk to Air Quality

Oil exposed to the atmosphere has the potential to contribute to air pollutants through evaporation of the volatile components of the oil. The number of spills estimated to occur as a result of typical proposed actions in the WPA and CPA are presented in Chapter 4.4.1.1. Estimates of the contribution of spills to the total volume of volatile hydrocarbons are provided in Chapters 4.2.1.4 and 4.3.1.4.

Analysis of Spill Risk to Marine Mammals

Risk from Offshore Spills ≥1,000 bbl

Spills occurring in or being transported through coastal waters as a result of a proposed action may contact groups of bottlenose dolphin, Atlantic spotted dolphin, or the West Indian manatee. Figure 4-16 depicts the locations of marine mammal habitats in coastal waters that were analyzed by the OSRA model. Figure 4-16 also provides the probabilities of a spill ≥1,000 bbl occurring from a proposed action in either the WPA or the CPA and the slick reaching identified marine mammal coastal habitats within 10 days. The OSRA modeling results indicate that there is a 5-8 percent probability of a spill ≥1,000 bbl occurring as a result of a proposed action in the WPA and the slick reaching the Texas State waters used by marine mammals within 10 days. The probability of an oil spill ≥1,000 bbl occurring as a result of a proposed action in the CPA and the slick reaching Texas coastal waters within 10 days is 1 percent. Coastal waters of Louisiana west of the Mississippi River have a 9-19 percent and 1-2 percent risk of being contacted within 10 days by a slick resulting from an offshore spill ≥1,000 bbl related to a proposed action in the CPA and WPA, respectively. There is a 2-4 percent risk of a spill occurring from a proposed action in the CPA and the slick contacting Louisiana coastal waters east of the Mississippi River mouth within 10 days. The OSRA model projected a <0.5 percent chance of a slick from a spill ≥1,000 bbl reaching the coastal waters east of Louisiana within 10 days as a result of either proposed actions (Figure 4-16).

Figure 4-17 shows the geographic locations analyzed by the OSRA model to estimate the risk of oil-spill occurrence and contact to areas predictably used by manatees. The probability of a spill ≥1,000 bbl occurring from a proposed action and the slick reaching manatee areas within 10 days was <0.5 percent, except for the manatee habitat located off the shoreline from eastern Louisiana to Alabama. Under the high-case resource development scenario, there is a 1 percent likelihood of a spill ≥1,000 bbl occurring from a proposed action in the CPA and reaching this manatee area.

Risk from All Offshore Spills

About 500-22,000 bbl of oil are estimated to be spilled in offshore waters over a 40-year period from the estimated 473-910 spill events as a result of a proposed action in the WPA, and about 1,000-23,000 bbl of oil is estimated to be spilled in offshore waters from the estimated 956-2,227 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have low probability of occurrence.

Analysis of Spill Risk to Sea Turtles

Risk from Offshore Spills ≥1,000 bbl

Spills occurring as a result of a proposed action and oil slicks migrating through coastal waters could reach coastal sea turtle habitats. Figure 4-19 maps the locations analyzed by the OSRA model in calculating the risk of an oil slick contacting the general, mating, and nesting habitats of sea turtles. The table below provides the geographic areas and months used for the OSRA model. Working with FWS, the MMS determined the months (listed in the table below) when sea turtles used the identified coastal habitats. The model results present the likelihood of slicks reaching the identified locations only during these months.

State	Geographic Area Type	Habitat Use	Seasonality
Tamaulipas	Coastal beaches	Nesting	April-September
Tamaulipas	State coastal waters	Mating	March-July
Tamaulipas	State coastal waters	General	year round
TX	Coastal beaches	Nesting	April-September
TX	State coastal waters	Mating	March-July
TX	State coastal waters	General	year round
LA	Chandeleur Islands	Nesting	April-November
LA	State coastal waters	General	year round
LA	Chandeleur Islands	Mating	March-July
MS-AL	Coastal beaches	Nesting	April-November
MS-AL	State coastal waters	Mating	March-July
MS-AL	State coastal waters	General	year round
FL Panhandle	Coastal beaches	Nesting	April-November
FL Panhandle	State coastal waters	Mating	March-July
FL Panhandle	State coastal waters	General	year round
FL peninsula	Coastal beaches	Nesting	April-November
FL Peninsula	State coastal waters	Mating	March-July
FL Peninsula	State coastal waters	General	year round
Tortugas	Coastal beaches	Nesting	April-November
Tortugas	State coastal waters	Mating	March-July
Tortugas	State coastal waters	General	year round

Figure 4-19 provides the likelihood of an offshore spill ≥1,000 bbl occurring from a proposed action in either the WPA or the CPA and reaching the identified coastal sea turtle habitats within 10 days during the identified months of use.

The OSRA modeling results indicate that there is a 5-8 percent probability that a spill ≥1,000 bbl occurring as a result of a WPA proposed action and the slick reaching Texas waters used by sea turtles as general coastal habitat within 10 days after a spill event. There is a 3-5 percent chance that one or more spills would occur and the slick reaching Texas waters within 10 days after the spill occurrence during mating season. There is a <0.5-2 percent chance that a spill ≥1,000 bbl would occur from a WPA proposed action and the slick reaching shore within 10 days during Texas's sea turtle nesting season.

The probability of an offshore oil spill ≥1,000 bbl occurring as a result of a proposed action in the CPA and the slick reaching Louisiana coastal waters used by turtles as general coastal habitat within 10 days ranges from 2 to 19 percent. The Chandeleur Islands is the only area in Louisiana considered sea turtle habitat for mating and nesting; there is up to a 1 percent chance that this habitat would be contacted by slick from an offshore spill ≥1,000 bbl occurring as a result of a proposed action.

The OSRA model results show that there is a <0.5 percent chance that coastal areas in Mexico, Mississippi, Alabama, or Florida, when serving as sea turtle habitat, would be contacted by an oil slick resulting from an offshore spill ≥1,000 related to a proposed action in the CPA or WPA.

Tables 4-45 and 4-46 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from All Offshore Spills

The MMS estimates that about 500-22,000 bbl of oil would be spilled in offshore waters from an estimated 473-910 spills over the 40-year life of a proposed action in the WPA and about 1,000-23,000 bbl of oil would be spilled in offshore waters from an estimated 956-2,227 spills over the 40-year life of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size class of ≥1,000 bbl and one in the size class of ≥10,000 bbl.

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probably of occurrence.

Analysis of Spill Risk to Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

Risk from Offshore Spills ≥1,000 bbl

Figure 4-20 provides the results of MMS's analysis of the risk of a spill ≥1,000 bbl occurring offshore and reaching endangered beach mice habitat within 10 days as a result of a proposed action in either the CPA or WPA. There is a <0.5 percent chance that one or more offshore spills ≥1,000 bbl would occur and contact the shoreline inhabited by the Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice during the life of a proposed action (2003-2042).

Risk from Offshore Spills <1,000 bbl

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

No coastal spills are estimated to occur in Mississippi, Alabama, or Florida coastal waters as a result of a proposed action in the CPA.

Analysis of Spill Risk to Marine Birds

Risk from All Offshore Spills

About 500-22,000 bbl of oil are estimated to be spilled in offshore waters over a 40-year period from the estimated 473-910 spill events as a result of a proposed action in the WPA, and about 1,000-23,000 bbl of oil are estimated to be spilled in offshore waters from the estimated 956-2,227 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl.

There is a 6-18 percent chance of two spills ≥1,000 bbl occurring in the CPA over the next 40 years as a result of a proposed action. There is a 2-5 percent chance of two spills ≥1,000 occurring in the WPA over the 40-year life of a proposed action.

Analysis of Spill Risk to Coastal Birds

The risk of contact to coastal birds from spills related to proposed action operations is dependent upon the likelihood that a spill occurs and the likelihood that the spilled oil reaches the shore areas inhabited or used by these birds.

Risk from Offshore Spills ≥1,000 bbl

The risk of contact to coastal birds from offshore spills ≥1,000 bbl is dependent upon (1) the likelihood that oil spills occurring from proposed action operations could be transported to the shoreline identified as coastal bird habitats and (2) oil-spill contact occurs during the period that specific coastal birds are present in the area. Figures 4-21 through 4-31 identify the shoreline areas representing identified coastal bird type habitat that were analyzed for spill risk. The following table lists the coastal birds types and the periods when the birds are expected to occupy identified habitats that were used for this OSRA model run.

Coastal Bird Type	When Birds Occupy Identified Habitat Areas
Diving birds	year round
Gulls, terns, charadriid allies	year round
Raptor birds	year round
Charadriid shorebirds	year round
Wading birds	year round
Waterfowl	year round
Snowy plover	February-August
Brown pelican	year round
Whooping crane	November-April
Bald eagle	year round
Piping plover	July-May

Figures 4-21 through 4-31 also provide the results of MMS's model trajectory simulation. Probabilities shown represent the likelihood that a spill ≥1,000 bbl would occur offshore as a result of a proposed action in either the CPA or the WPA and the slick would reach various coastal bird habitats during the periods when the birds are known to use the area and within 10 days after the spill incident. The probabilities of occurrence and contact within 10 days for all species and habitats modeled range between <0.5 and 18 percent.

In addition to accounting for wind and current transport and risk of spill occurrence, the combined probabilities incorporate the length of time each coastal bird type occupies the identified habitat. For example, the whooping crane occupies the identified habitat for 6 months out of the year. The chance of a spill occurring offshore and the slick reaching within 10 days this habitat during those 6 months is calculated to be <0.5 percent. In contrast, waterfowl are found everywhere along the Gulf's shoreline year round; thus, the risk of spill occurrence and contact is higher (9-18% from a proposed action in the CPA and 5-8% from a proposed action in the WPA). Given the widespread distribution of waterfowl throughout the Gulf Coast, if an oil spill from a proposed action were to occur and reach land, waterfowl habitat would likely be contacted.

Tables 4-45 and 4-46 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from Offshore Spills <1,000 bbl

About 500-22,000 bbl of oil is estimated to be spilled in offshore waters over a 40-year period from the estimated 473-910 spill events as a result of a proposed action in the WPA, and about 1,000-23,000 bbl of oil is estimated to be spilled in offshore waters from the estimated 956-2,227 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl.

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach land. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters and to reach shore. Should a slick from such a spill make landfall, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probability of occurrence.

Based on the assumption that spill occurrence is proportional to the volume of oil handled, bird populations located near the coastal waters of the Galveston/Houston/Texas City area have the greatest risk of being contacted by coastal spills related to a proposed action in the WPA. A total of 70 percent of all oil estimated to be produced as a result of a proposed action in the WPA is projected to be brought into this area. Bird populations in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River, including Barataria Bay, have the greatest risk of being contacted by spills from operations related to a CPA proposed action. The greatest risk of contact would be from the assumed 3,000-bbl spill should it occur within or near the identified habitat areas when the birds are occupying those habitats.

Analysis of Spill Risk to Gulf Sturgeon

In 1996, Gulf sturgeon occurred from the Mississippi River to Charlotte Harbor in western Florida (Patrick, personal communication, 1996). Figure 4-17 shows this habitat.

Risk from All Offshore Spills

Figure 4-17 provides the results of the analysis of the risk of a spill ≥1,000 bbl occurring offshore as a result of a proposed action in either the CPA or the WPA and reaching the known locations of the Gulf sturgeon within 10 days after the spill event. The likelihood of a spill ≥1,000 bbl occurring within the WPA area and reaching locations used by the Gulf sturgeon within 10 days after the spill incident is <0.5 percent. There is a 2-5 percent chance that a spill ≥1,000 bbl would occur within the CPA as a result of a proposed action and would reach coastal waters where the Gulf sturgeon has been found within 10 days. The risk of exposure of Gulf sturgeon to such a spill would be dependent upon the species abundance and density as well as the size and persistence of the slick.

About 500-22,000 bbl of oil are estimated to be spilled in offshore waters over a 40-year period from the estimated 473-910 spill events as a result of a proposed action in the WPA, and about 1,000-23,000 bbl of oil are estimated to be spilled in offshore waters from the estimated 956-2,227 spills as a result of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size group ≥1,000 bbl and one spill incident in the size group ≥10,000 bbl.

For spills <1,000 bbl, only those >50 bbl would be expected to have a chance of persisting as a cohesive slick long enough for the slick to reach coastal waters. Few offshore spills 50-1,000 bbl are estimated to occur as a result of a proposed action, and few of these slicks are expected to occur proximate to State waters. Should a slick from such a spill reach coastal waters, the volume of oil remaining in the slick is expected to be small.

Risk from Coastal Spills

The coastal waters inhabited by the Gulf sturgeon are not expected to be at risk from coastal spills resulting from a proposed action in the CPA. Considering the projected use of shore bases in support of activities resulting from a proposed action in the CPA (Chapter 4.1.2.1), very few of the estimated 55-125 coastal spills resulting from a proposed action in the CPA are likely to occur east of the Mississippi River. No coastal spills are projected to occur in Mississippi, Alabama, or Florida coastal waters as a result of a proposed action in the CPA.

Analysis of Spill Risk to Fish Resources, Essential Fish Habitats, and Commerical Fisheries

The essential fish habitat (EFH) for the Gulf of Mexico includes all estuarine and marine waters and substrates from the shoreline to the seaward limit of the U.S. Exclusive Economic Zone (EEZ). Coastal areas that are considered EFH include wetlands and areas of submerged vegetation. Live-bottom features and their biotic assemblages are also considered EFH. Any spill that occurs as a result of a proposed action in the WPA or CPA will contact EFH.

Risk of All Offshore Spills

Figure 4-8 shows that there is a 6-18 percent chance of two spills ≥1,000 bbl occurring from a proposed action in the CPA over the next 40 years, and Figure 4-9 shows a 2-5 percent chance of two spills ≥1,000 occurring from a proposed action in the WPA.

The MMS estimates that about 500-22,000 bbl of oil would be spilled in offshore waters from an estimated 473-910 spills over the 40-year life of a proposed action in the WPA and about 1,000-23,000 bbl of oil would be spilled in offshore waters from an estimated 956-2,227 spills over the 40-year life of a proposed action in the CPA; most (about 97%) of these spills would be ≤1 bbl. These volumes include volumes from one spill incident in the size class of ≥1,000 bbl and one in the size class of ≥10,000 bbl.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probability of occurrence.

Based on the assumption that spill occurrence is proportional to the volume of oil handled, the most likely locations of the 17-40 coastal spills >1 bbl estimated to occur from operations related to both proposed actions are the coastal locations proximate to the major oil pipeline shore facilities. Sensitive coastal resources located within the coastal waters of the Galveston/Houston/Texas City area have the greatest risk of being contacted by coastal spills related to a proposed action in the WPA. A total of 70 percent of all oil estimated to be produced as a result of a proposed action in the WPA is projected to be brought into this area. Sensitive coastal resources located in eastern Louisiana, from Atchafalaya Bay to east of the Mississippi River, including Barataria Bay, have the greatest risk of being contacted by spills related to CPA proposed action support operations. The greatest risk of contact would be from the assumed 3,000-bbl spill should it occur when and where fish species are most vulnerable.

Analysis of Spill Risk to Recreational Beaches

The following table lists the major recreational beach areas and the timeframes analyzed for spill risk.

Recreational Beaches	Major Seasonal Use
Texas	
Coastal Bend Area Beaches	April-September
Matagorda Area Beaches	April-September
Galveston Area Beaches	April-September
Sea Rim State Park	April-September
Louisiana	
Beaches	April-November
Alabama/Mississippi	
Gulf Islands	April-November
Gulf Shores	April-November
Florida	
Panhandle Beaches	April-November
Big Bend Beaches	April-November
Southwest Beaches	April-November
Ten Thousand Islands	April-November

Risk of All Offshore Spills

Figure 4-14 provides the results of the analysis of the risk of a spill ≥1,000 bbl occurring offshore as a result of a proposed action in either the CPA or WPA and reaching major recreational beach areas. The likelihood of a spill ≥1,000 bbl occurring from a proposed action in the WPA and reaching Texas recreational beaches within 10 days is <0.5-2 percent. Western Louisiana beaches have a 1 percent chance that oil spill ≥1,000 bbl would occur from a WPA proposed action and contact the area within 10 days.

The likelihood of a spill ≥1,000 bbl occurring from a proposed action in the CPA and reaching recreational beaches in Louisiana within 10 days is 2-4 percent. The likelihood of a spill occurring from a CPA proposed action and contacting beaches in Texas is <0.5 percent.

Tables 4-45 and 4-46 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

There is a <0.5 percent chance of a spill ≥1,000 bbl occurring from a proposed action in either the CPA or WPA and reaching recreational beaches in Mississippi, Alabama, or Florida within 10 days.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probably of occurrence.

Analysis of Spill Risk to Archaeological Resources

Since possible locations of historic and prehistoric resources are widespread along the Gulf Coast, specific resource locations were not analyzed by the OSRA model trajectory simulations.

Risk from All Offshore Spills

The probabilities of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was used as an indicator of the risk of an offshore spill reaching archaeological resources. Figure 4-13 shows the Gulf of Mexico coastal counties and parishes having a risk >0.5 percent of being contacted within 10 days by an offshore spill ≥1,000 bbl occurring as a result of a proposed action in the CPA or WPA. Most counties and parishes have a <0.5 percent probability of a spill ≥1,000 bbl occurring and contacting (combined probability) their shorelines within 10 days; five counties in Texas and six parishes in Louisiana have probabilities of 1-8 percent of an OCS offshore spill ≥1,000 bbl occurring and reaching their shorelines within 10 days. Plaquemines Parish, Louisiana, has the greatest risk (4-8%) of a spill occurring and contacting its shoreline within 10 days as a result of a CPA proposed action. In Texas, Matagorda County has the greatest risk (1-2%) of being contacted within 10 days by a slick occurring offshore as a result of a WPA proposed action.

Tables 4-45 and 4-46 provide MMS estimates of the likely size and remaining volumes of oil slicks of a "typical" CPA oil and a "typical" WPA oil for several time increments after spills of assumed size 4,600 bbl occur. In the CPA, it is estimated that 50 bbl would remain in the slick 10 days after the spill; about 1 km of shoreline would be contacted if the 10-day-old, 50-bbl slick reached shore. In the WPA, it is estimated that the slick would dissipate within 4 days. It is estimated that 10-50 km of land would be contacted if a slick from a WPA proposed action reached shore within 24 hours after the spill incident.

Risk from Coastal Spills

Approximately 80-175 spills are estimated to occur within Gulf coastal waters from activities supporting a CPA proposed action and a WPA proposed action combined; most (about 75%) of these spills would be ≤1 bbl. The most likely locations of the estimated 17-40 coastal spills >1 bbl would be proximate to the major oil pipeline shore facilities. The MMS estimates coastal spills related to the proposed actions could introduce 200-3,200 bbl of oil into coastal waters of Texas and 200-3,500 bbl of oil into coastal waters of Louisiana. Except for a 3,000-bbl spill estimated to occur in Louisiana coastal waters under the high resource-estimate scenario, MMS estimates that coastal spills ≥1,000 bbl resulting from a proposed action have a low probably of occurrence.

4.4.1.2. Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellbore or wellhead are called blowouts. Historically, most blowouts have occurred during development drilling operations, but blowouts can happen during exploratory drilling, production, well completions, or workover operations. One-third of blowouts were associated with shallow gas flows. Most blowouts last for a short duration, with half lasting less than a day.

From 1992 to 2000, a total of 35 blowouts have occurred in the OCS with an average of 4 blowouts per 1,000 well starts. From 1995 to 2000, the blowout rate rose from 1 per 1,000 well starts to 6 per 1,000 well starts. For this EIS, blowout rates of 7 per 1,000 well starts and 2 per 1,000 existing wells were used. Since 1999, there has been one blowout per year in deepwater (> 1,000 ft), which is five blowouts per well start.

Blowouts may result in the release of synthetic drilling fluid or loss of oil. From 1992 to 2000, less than 10 percent of the blowouts have resulted in spilled oil. Of the 35 blowouts that have occurred during this period, the following three resulted in oil release:

Year	Amount Spilled	Water Depth
2000	0.5 bbl of oil	309 ft
2000	150-200 bbl of crude oil	2,223 ft
1998	1.5 bbl of condensate	51 ft

In 1997, an MMS-funded study on the fate and behavior of oil well blowouts (S.L. Ross Environmental Research Ltd., 1997). Oil well blowouts generally involve two fluids—crude oil (or condensate) and natural gas. A highly turbulent zone occurs within a few meters of the discharge point, then rapidly loses momentum with distance. In water depths <300 m, the flow of natural gas determines the initial dimensions of oil slicks from subsea blowouts. As the gas rises, it entrains oil and water in the vicinity and carries them to the surface. In these water depths, currents have little effect compared to the plume's velocity. In deeper water (>300 m) with lower temperatures and higher pressures, gas may form hydrates and the volume of gas may be depleted through dissolution into the water. Larger droplets will reach the surface faster and closer to the source, while smaller droplets will be carried farther by the currents before reaching the surface.

Severe subsurface blowouts could resuspend and disperse abundant sediments within a 300-m radius from the blowout site. The fine sediment fraction could be resuspended for more than 30 days. The coarse sediment fraction (sands) would settle at a rapid rate within 400 m from the blowout site, particularly in a 30-m water depth and a 35-cm/sec blowout scenario.

Prior to the 1980's, blowouts were the leading cause of fatalities on the OCS. One blowout-related fatality has occurred since 1986.

The MMS requires the use of blowout preventors (BOP) and that BOP systems are tested at specific times: (1) when installed, (2) before 14 days have elapsed since the last BOP pressure test, and (3) before "drilling out" each string of casing or a liner (30 CFR 250.407). A 1996 MMS-funded study looked at the reliability of BOP's (Tetrahedron, Inc., 1996). This study found that subsea BOP's had a lower failure rate (28%) than surface BOP's (44%). A test was considered to have failed if any piece of equipment had to be physically repaired or sent for repairs after the test.

An estimated 2-4 blowouts could occur from activities resulting from a proposed action in the CPA. An estimated 1-2 blowouts could occur from activities resulting from a proposed action in the WPA.

For OCS Program activities in the Gulf of Mexico for the years 2003-2042, the estimated total number of blowouts is 215-259.

4.4.1.3. Vessel Collisions

The MMS data show that, from 1995 to 2001, there were 56 OCS-related collisions. Most collision mishaps are the result of service vessels colliding with platforms or vessel collisions with pipeline risers. Approximately 10 percent of vessel collisions with platforms in the OCS caused diesel spills. To date, the largest diesel spill associated with a collision occurred in 1979 when an anchor-handling boat collided with a drilling platform in the Main Pass Area, spilling 1,500 bbl.

Safety fairways, traffic separation schemes, and anchorages are the most effective means of preventing vessel collisions with OCS structures. In general, fixed structures such as platforms and drilling rigs are prohibited in fairways. Temporary underwater obstacles, such as anchors and attendant cables or chains attached to floating or semisubmersible drilling rigs, may be placed in a fairway under certain conditions. A limited number of fixed structures may be placed at designated anchorages. The USCG's requirements for indicating the location of fixed structures on nautical charts and for lights, sound-producing devices, and radar reflectors to mark fixed structures and moored objects also help minimize the risk of collisions. In addition, the USCG 8th District's Local Notice to Mariners (monthly editions and weekly supplements) informs Gulf of Mexico users about the addition or removal of drilling rigs and platforms, locations of aids to navigation, and defense operations involving temporary moorings. Marked platforms often become aids to navigation for vessels (particularly fishing boats and vessels supporting offshore oil and gas operations) that operate in areas with high densities of fixed structures.

The National Offshore Safety Advisory Committee (NOSAC, 1999) examined collision avoidance measures between a generic deepwater structure and marine vessels in the Gulf of Mexico. The NOSAC offered three sets of recommendations: (1) voluntary initiatives for offshore operators; (2) joint government/industry cooperation or study; and (3) new or continued USCG action. The NOSAC (1999) proposes that oil and gas facilities be used as aids-to-navigation because of their proximity to fairways, fixed nature, well-lighted decks, and inclusion on navigational charts. Mariners intentionally set and maintain course toward these facilities, essentially maintaining a collision course. Unfortunately, most deepwater facilities do not install collision avoidance radar systems to alert offshore facility personnel of a potentially dangerous situation. The NOSAC estimates that 7,300 large vessels (tankships, freight ships, passenger ships, and military vessels) pass within 35 mi of a typical deepwater facility each year. This estimate resulted in approximately 20 transits per day for the 13 deepwater production structures existing in 1999. The NOSAC found the total collision frequency to be approximately one collision per 250 facility-years (3.6×10^{-3} per year). The NOSAC estimated that if the number of deepwater facilities increases to 25, the estimated total collision frequency would increase to one collision in 10 years. A cost-benefit analysis within the report did not support the use of a dedicated standby vessel for the generic facility; however, the analysis did support the use of a radar system on deepwater facilities if the annual costs of the system were less than or equal to $124,500.

The OCS-related vessels could collide with marine mammals, turtles, and other marine animals during transit. To limit or prevent such collisions, NOAA Fisheries provides all boat operators with "Whalewatching Guidelines," which is derived from the Marine Mammal Protection Act. These guidelines suggest safe navigational practices based on speed and distance limitations when encountering marine mammals. The frequency of vessel collisions with marine mammals, turtles, or other marine animals probably varies as a function of spatial and temporal distribution patterns of the living resources, the pathways of maritime traffic (coastal traffic is more predictable than offshore traffic), and as a function of vessel speed, the number of vessel trips, and the navigational visibility.

4.4.1.4. Chemical and Drilling-Fluid Spills

A recent study of chemical spills from OCS activities determined that only two chemicals could potentially impact the marine environment—zinc bromide and ammonium chloride (Boehm et al., 2001). Both of these chemicals are used for well treatment or completion and therefore are not in continuous use; thus, the risk of a spill for these chemicals is very small. Most other chemicals are either nontoxic or used in small quantities.

Zinc bromide is of particular concern because of the toxic nature of zinc. The study modeled a spill of 45,000 gallons of a 54-percent aqueous solution, which would result in an increase in zinc concentrations to potentially toxic levels. Direct information on the toxicity of zinc to marine organisms is not available; however, the toxicity of zinc to a freshwater crustacean (*Ceriodaphnia dubia*) indicated that exposure to 500 ppb zinc results in measurable effects. One factor not considered in the model is the rapid precipitation of zinc in marine waters, which would minimize the potential for impact.

Ammonium chloride was modeled using potassium chloride as a surrogate. The model looked at a spill of 4,717 kg of potassium chloride powder. The distribution of potassium would overestimate the distribution of ammonia released during a spill. The model indicated that close to the release point, ammonia concentrations could exceed toxic levels for time scales of hours to days. Additional information on the degradation of ammonia in seawater would be needed for a more complete evaluation.

Accidental riser disconnects could result in the release of large quantities of drilling fluids and are of particular concern when synthetic-based drilling fluids (SBF) are in use. The use of SBF occurs primarily in deepwater where large volumes can be released. Three recent (2000-2001) riser disconnects occurred in the Gulf of Mexico OCS. Each release occurred as a result of unplanned riser disconnect near the seafloor. The contents of the riser was discharged within an hour of the disconnect. In all cases, approximately 600-800 bbl of SBF were discharged at the seafloor. The fate and effects of such a large release of SBF have never been studied.

4.4.2. Spill Response

Offshore Response and Cleanup

A number of cleanup techniques are available for response to an oil spill. Open-water response options include mechanical recovery, chemical dispersion, in-situ burning, or natural dispersion. Although bioremediation was at one time considered for use in open water, studies have shown that this technique is not an effective spill-response option in open water because of the high degree of dilution of the product and the rapid movement of oil in open water. Effective use of bioremediation requires that the products remain in contact with the oil for extended periods of time.

Single or multiple spill-response cleanup techniques may be used in abating a spill. The cleanup technique chosen for a spill response will vary depending upon the unique aspects of each situation. The selected mix of countermeasures will depend upon the shoreline and natural resources that may be impacted; the size, location, and type of oil spilled; weather; and other variables. The overall objective of on-water recovery is to minimize the risk of impact by preventing the spread of free-floating oil. The physical and chemical properties of crude oil can greatly affect the effectiveness of containment and recovery equipment, dispersant application, and *in-situ* burning. It is expected that oil found in the proposed action areas (CPA and WPA) could range from a medium-weight oil to light condensates.

Mechanical Cleanup

Generally, mechanical containment and recovery is the primary oil-spill-response method used (33 CFR 153.305(a)). Mechanical recovery is the process of using booms and skimmers to pick up oil from the water surface. In a typical offshore oil-spill scenario, a boom is deployed in a V, J, or U configuration to gather and concentrate oil on the surface of the water. The oil is gathered in the wide end of the boom (front) and travels backward toward the narrow apex of the boom (back). The skimmer is positioned at the apex of the boom, where the oil is the thickest. The skimmer recovers the oil by sucking in the top layer via a weir skimmer, or the oil adheres to and is removed from a moving surface (i.e., an oleophylic skimmer). The oil is then pumped from the skimmer to temporary storage on an attendant vessel or barge, the latter of which serves as the skimming platform. When this on-board storage is full, the oil must be pumped into a larger storage vessel.

Mechanical oil-spill-response equipment that is contractually available to the operators through Oil Spill Removal Organization (OSRO) membership or contracts would be called out to respond to an offshore spill in the CPA or WPA. Each individual operator's response to a spill would differ according to the location of the spill, the volume and source of the spill, the OSRO under contract, etc. At this time, in the Gulf of Mexico, there are three major OSRO's that can respond to spills in the open ocean: (1) Clean Gulf Associates, (2) Marine Spill Response Corporation (MSRC), and (3) National Response Corporation. The equipment owned by these OSRO's is strategically located near the busier port areas throughout the Gulf to service the oil and gas exploration and production operators and, in some cases, the marine transportation industry. Numerous smaller OSRO's that stockpile additional shoreline and nearshore response equipment are also located throughout the Gulf coastal area.

In consideration of the present location of the major OSRO equipment stockpiles, it is expected that the oil-spill-response equipment needed to respond to an offshore spill in the CPA or WPA can be called out from one or more of the following major oil-spill equipment base locations: Corpus Christi, Ingleside, Port Arthur, and Galveston, Texas; Lake Charles, New Iberia, Houma, Fourchon, Fort Jackson, and Venice, Louisiana; Pascagoula, Mississippi; Mobile, Alabama; or Tampa, Florida. Response times for this equipment would vary, dependent on the location of the equipment, the staging area, and the spill site; and on the transport requirements for the type of equipment procured.

It is assumed that 10-30 percent of a spill ≥1,000 bbl of a light- to medium-weight oil can be mechanically removed from the water prior to the spill making landfall (U.S. Congress, Office of Technology Assessment, 1990). Even when response efforts occur quickly, smaller spills (<50 bbl) in an offshore environment may not be recoverable by mechanical skimming equipment because such small spills spread quickly to a minimal thickness. Often, these smaller spills dissipate prior to equipment reaching the spill site.

Should an oil spill occur during a storm, spill response from shore would occur following the storm. Spill response would not be possible while storm conditions continued, given the sea state limitations for skimming vessels and containment boom deployment. However, oil released onto the ocean surface during a storm event would be subject to accelerated rates of weathering and dissolution (i.e., oil and water would be agitated, forcing oil into smaller droplets and facilitating dissolution of the high end aromatic compounds present).

Dispersants

When dispersants are applied to spilled crude oil, the surface tension of the oil is reduced. This allows normal wind and wave action to break the oil into tiny droplets, which are dispersed into the upper portion of the water column. Natural processes then break down these droplets much quicker than they would if the oil were allowed to remain on the water surface.

Dispersants are required to be used in accordance with the Regional Response Teams' Preapproved Dispersant Use Manual. Dispersant use would be in accordance with the restrictions for specific water depths or distances from shore. For a deepwater >1,000 ft water depth) spill ≥1,000 bbl, dispersant application may be a preferred response in the open-water environment to prevent oil from reaching a coastal area, in addition to mechanical response.

Based on the present location of dispersant stockpiles and dispersant application equipment in the Gulf of Mexico, it is expected that the dispersants and dispersant application aircraft initially called out for an oil-spill response to an offshore spill in the CPA or WPA will come from Houma, Louisiana. Response times for this equipment would vary, depending on the spill site and on the transport time for additional supplies of dispersants to arrive at a staging location**.** Based on historic information, this EIS assumes that dispersant application will be effective on 20-50 percent (S.L. Ross Environmental Research Ltd., 2000) of the treated oil.

In-situ Burning

In-situ burning is an oil-spill cleanup technique that involves the controlled burning of the oil at or near a spill site. The use of this spill-response technique can provide the potential for the removal of large amounts of oil over an extensive area in less time than other techniques. *In-situ* burning involves the same oil collection process used in mechanical recovery, except instead of going into a skimmer, the oil is funneled into a fire-boom, a specialized boom that has been constructed to withstand the high temperatures from burning oil. Fire resistant booms are used to isolate the oil from the source of the slick. The oil in the fire-boom is then ignited and allowed to burn. While *in-situ* burning is another method for disposing of oil that has been collected in a boom, this method is typically more effective than skimmers when the oil is highly concentrated.

For oil to ignite on water, it must be at least 2-3 mm thick. Most oils must be contained with fireproof boom to maintain this thickness. Oils burn at a rate of 3-4 mm per minute. Most oils will burn, although emulsions may require treatment before they will burn. Water in the oil will affect the burn rate; however, recent research has indicated that this effect will be marginal. One approximately 200–m length of fire resistant boom can contain up to 11,000 gallons of oil, which takes about 45 minutes to burn. In total, it would take about three hours to collect this amount of oil, tow it away from a slick, and burn it (Fingas, 2001). Response times for bringing a fire-resistant boom onsite would vary, dependent on the location of the equipment, the staging area, and the spill site.

Natural Dispersion

In some instances, the best response to a spill may be to allow the natural dispersion of a slick to occur. Natural dispersion may be a preferred option for smaller spills of lighter nonpersistent oils and condensates that form slicks that are too thin to be removed by conventional methods and are expected to dissipate rapidly, particularly if there are no identified potential impacts to offshore resources and a potential for shoreline impact is not indicated. In addition, natural dispersion may also be a preferred option in some nearshore environments when the potential damage caused by a cleanup effort could cause more damage than the spill itself.

Oil-Spill Response Assumptions Used in the Analysis of a Most Likely Spill $\geq$1,000 bbl Incident Related to a Proposed Action

Refer to Tables 4-45 and 4-46 for the estimated amounts of oil that will either be removed by the application of dispersants or mechanically recovered for the 4,600-bbl pipeline spill scenarios analyzed in this EIS. These tables reflect recovery and removal estimates for two different scenarios:

- a 4,600-bbl spill of 35^{o} API oil lost over 12 hours as result of a potential pipeline break during winter conditions at High Island Area; and
- a 4,600-bbl spill of 30^{o} API oil lost over 12 hours as result of a potential pipeline break during summer conditions at Ship Shoal Area.

The assumptions used in calculating the amounts removed as a result of dispersant use and mechanical recovery efforts for the two 4,600-bbl spill scenarios are listed below.

- The spills occurred and were reported at 6 a.m.
- The 35^{o} API oil did not emulsify; the 30^{o} API oil did emulsify.

- Spill-response efforts were conducted during daylight hours only.
- Mechanical response equipment (i.e., fast-response units having a USCG de-rated skimming capacity of 3,400 bbl/day) owned by the oil-spill-response cooperative, Clean Gulf Associates, was procured from Galveston, Texas, and Lake Charles, Louisiana, for response to the High Island Area Block A-425 scenario.
- Mechanical response equipment (i.e., fast-response units having a USCG de-rated skimming capacity of 3,400 bbl/day) owned by the oil-spill-response cooperative, Clean Gulf Associates, was procured from Houma and Venice, Louisiana, for response to the Ship Shoal Area Block 281 scenario.
- Dispersant application aircraft was deployed for both scenarios from Houma, Louisiana. This location also served as the staging location for loading dispersants. Three aircraft from this location were deployed for dispersant application in the first few days of the scenario—two DC3's and one DC4.
- Sea-state conditions: during the summer—2-ft waves; during the winter — 4-ft waves.
- A dispersant effectiveness rate of 30 percent for the treated oil was assumed (S.L. Ross Environmental Research Ltd., 2000).
- Because of the projected stable emulsion formation of the 30^{o} API oil during the summer scenario, it was assumed that dispersant application would no longer be effective after 48 hours in this scenario.

Onshore Response and Cleanup

Offshore response and cleanup is preferable to shoreline cleanup; however, if an oil slick reaches the coastline it is expected that the specific shoreline cleanup countermeasures identified and prioritized in the appropriate Area Contingency Plans (ACP's) for various habitat types would be used. The sensitivity of the contaminated shoreline is the most important factor in the development of cleanup recommendations. Shorelines of low productivity and biomass can withstand more intrusive cleanup methods such as pressure washing. Shorelines of high productivity and biomass are very sensitive to intrusive cleanup methods, and in many cases, the cleanup is more damaging than allowing natural recovery.

Oil-spill response planning in the United States is accomplished through a mandated set of interrelated plans. The ACP represents the third tier of the National Response Planning System and was mandated by OPA 90. The ACP's cover subregional geographic areas. The ACP's are a focal point of response planning, providing detailed information on response procedures, priorities, and appropriate countermeasures. The Gulf coastal area is covered by seven ACP's. The ACP's are written and maintained by Area Committees assembled from Federal, State, and local governmental agencies that have pollution response authority; nongovernmental participants may attend meetings and provide input. The coastal Area Committees are chaired by respective Federal On-Scene Coordinators from the appropriate USCG Marine Safety Office and are comprised of members from local or area-specific jurisdictions. Response procedures identified within an ACP reflect the priorities and procedures agreed to by members of the Area Committees.

The single most frequently recommended spill-response strategy for the areas identified for protection in all of the applicable ACP's is the use of a shoreline boom to deflect oil away from coastal resources such as seagrass beds, marinas, resting areas for migratory birds, bird and turtle nesting areas, etc. If a shoreline is oiled, the selection of the type of shoreline remediation to be used will depend on the following: (1) the type and amount of oil on the shore; (2) the nature of the affected coastline; (3) the depth of oil penetration into the sediments; (4) the accessibility and the ability of vehicles to travel along the shoreline; (5) the possible ecological damage of the treatment to the shoreline environment; (6) weather conditions; (7) the current state of the oil; and (8) political considerations.

Shoreline Cleanup Countermeasures

The following descriptions regarding the shoreline cleanup of spills reflect a generalization of the site-specific guidance provided in the ACP's applicable to the Gulf of Mexico. The ACP's applicable to the Gulf coastal area cover a vast geographical area. The differences in the response priorities and procedures among the ACP's reflect the differences in the identified resources needing spill protection in the area covered by each ACP.

- *Barrier Island/Fine Sand Beaches Cleanup*: After the oiling of a barrier island/fine sand beach with a light- to medium-weight oil, applicable cleanup options include manual removal, trenching (recovery wells), sediment removal, cold-water deluge flooding, shore removal/replacement, and warm-water washing. Other possible shoreline countermeasures include low-pressure, cold-water washing; burning; and nutrient enhancement. Responders are requested to avoid the following countermeasures: no action; high-pressure, cold-water washing; hot-water washing; slurry sand blasting; vacuum; and vegetation cutting. Passive collection (sorbents) is not recommended for medium-weight oils.
- *Fresh or Salt Marsh Cleanup*: In all cases, cleanup options that avoid causing additional damage to the marshes will be selected. After the oiling of a fresh or salt marsh with a light- to medium-weight oil, the preferred cleanup option would be to take no action. Another applicable alternative would be trenching (recovery wells). Shore removal/replacement, vegetation cutting, or nutrient enhancement could be used. The option of using vegetation cutting as a shoreline countermeasure will depend upon the time of the year and will be considered generally only if re-oiling of birds is possible. Chemical treatment, burning, and bacterial addition are also countermeasures that would also be considered. Responders are advised to avoid manual removal, debris removal/heavy equipment, sediment removal, cold-water flooding, high- or low-pressure cold-water washing, warm-water washing, hot-water washing, slurry sand blasting, and shore removal/replacement. Passive collection (sorbents) is not recommended for medium-weight oils.
- *Coarse Sand/Gravel Beaches Cleanup:* After the oiling of a coarse sand/gravel beach with a light- to medium-weight oil, applicable cleanup options are manual removal, trenching (recovery wells), sediment removal, cold-water deluge flooding, and shore removal/replacement. Other possible shoreline countermeasures include low-pressure, cold-water washing; burning; warm-water washing; and nutrient enhancement. Responders are requested to avoid the following countermeasures: no action; high-pressure, cold-water washing; hot-water washing; slurry sand blasting; vacuum; and vegetation cutting. Passive collection (sorbents) is not recommended for medium-weight oils.
- *Seawall/Pier Cleanup:* After the oiling of a seawall or pier with a light- to medium-weight oil, the applicable cleanup options include manual removal; cold-water flooding; low- and high-pressure, cold-water washing; warm-water washing; hot-water washing; slurry sand blasting; vacuum; and shore removal replacement. Other possible shoreline countermeasures listed include burning and nutrient enhancement. Responders are requested to avoid no action, trenching, sediment removal, and vegetation cutting. Passive collection (sorbents) is not recommended for medium-weight oils.

4.4.3. Environmental Impacts of Accidental Events

4.4.3.1. Impacts on Sensitive Coastal Environments

Impacts to the general vegetation and physical aspects of coastal environments by spills and cleanup response activities resulting from the proposed actions are considered in Chapters 4.4.3.1.1, 4.4.3.1.2, and

4.4.3.1.3. Potential impacts to barrier islands seaward of the barrier-dune system are considered in the coastal barrier beaches and associated dunes analysis. Potential impacts to barrier islands landward of the barrier-dune system are considered in the wetlands analysis. Impacts to animals that use these environments, the recreational value of beaches, and archaeological resources found there are described in impact analysis sections for those specific resources.

The types and sources of spills that may occur, their dissipation prior to contacting coastal resources, spill-response activities, and mitigation are described in Chapters 4.4.1 and 4.4.2.

4.4.3.1.1. Coastal Barrier Beaches and Associated Dunes

The fate of accidental oil spills in the Gulf of Mexico depends upon where each spill originates; the chemical composition and nature of the spilled oil; and the seasonal, meteorological, and oceanographic circumstances. Chapter 4.4.1.1 provides estimates of the number of oil spills that might result from a proposed action, as well as oil slick dispersal and weathering characteristics. Figure 4-13 provides the probability of an offshore spill ≥1,000 bbl occurring and contacting counties and parishes around the Gulf.

In coastal Louisiana, dune-line heights range from 0.5 to 1.3 m above mean high-tide level. In Mississippi and Alabama (coastal Subarea MA-1), dune elevations exceed those in Louisiana. For tides to carry oil from a spill across and over the dunes, strong southerly winds would have to persist for an extended time prior to or immediately after the spill. Strong winds required to produce such high tides would also accelerate dispersal and spreading of the oil slick, thereby reducing impact severity at the landfall site. Significant dune contact by a spill associated with a proposed action is very unlikely. A study in Texas showed that oil disposal on sand and vegetated sand dunes had no deleterious effects on the existing vegetation or on the recolonization of the oiled sand by plants (Webb, 1988).

Oil-spill cleanup operations can affect barrier beach stability. If large quantities of sand were to be removed during spill-cleanup operations, a new beach profile and sand configuration would be established in response to the reduced sand supply and volume. The net result of these changes could be accelerated rates of shoreline erosion, especially in a sand-starved, eroding-barrier setting such as found along the Louisiana Gulf Coast. To address these possible impacts, the Gulf Coast States have established policies to limit sand removal by cleanup operations.

Based on MMS analysis of the USCG data on all U.S. coastal spills (Chapter 4.4.1.1.7), MMS assumes that 32 percent of coastal spills that will occur as a result of a proposed action will occur in State offshore waters 0-3 mi from shore, 4 percent will occur in offshore waters 3-12 mi from shore, and 64 percent will occur in inland waters. It is assumed all offshore coastal spills will contact land and proximate resources. Most inshore spills resulting from a proposed action will occur from barge, pipeline, and storage tank accidents involving transfer operations, leaks, and pipeline breaks, which are remote from barrier beaches. When transporting cargoes to terminals, oil barges make extensive use of interior waterways, which are remote from barrier beaches. Most inland spills are assumed to have no contact with barrier beaches or dunes. For a barge or pipeline accident to affect a barrier beach, the accident would need to occur in offshore waters, on a barrier beach or dune, or inshore in the vicinity of a tidal inlet.

The September 1989 spill from a barge in the Mississippi Sound oiled the landward side of Horn Island, but not the Gulf side. Similarly, the October 1992 Greenhill Petroleum Corporation oil spill (blowout during production in State waters) just inland of East Timbalier Island, Louisiana, oiled inland shorelines but did not impact barrier beaches or dunes. Other smaller inland oil spills have impacted coastal islands similarly. Inshore pipelines or barge accidents are assumed to result in spilled oil contacting the inland shores of a barrier island, with unlikely adverse impacts to barrier beaches or dunes.

Proposed Action Analysis

The probabilities of proposed-action-related spills occurring in OCS waters and contacting various parishes and counties are provided in Chapter 4.4.1. The risk of offshore spills ≥1,000 bbl occurring and contacting barrier beaches is discussed in Chapter 4.4.1.1.8. Generally, the coastal, deltaic parishes of Louisiana have the highest risk of being contacted by an offshore spill resulting from a proposed action in the CPA; Plaquemines Parish has the highest probability. The probabilities of an offshore spill occurring and contacting coastal counties or parishes as a result of a proposed action in the WPA are generally higher for the region between Matagorda County, Texas, and Cameron Parish, Louisiana.

Coastal spills in offshore coastal waters or in the vicinity of Gulf tidal inlets present a greater potential risk to barrier beaches because of their close proximity. Inland spills that occur away from Gulf tidal inlets are generally not expected to significantly impact barrier beaches and dunes.

Oil that makes it to the beach may be either liquid weathered oil, an oil and water mousse, or tarballs. Oil is generally deposited on beaches in lines defined by wave action at the time of landfall. Initially, components of oil on the beach will evaporate more quickly under warmer conditions. Under high tide and storm conditions, oil may return to the Gulf and be carried higher onto the beach. Oil that remains on the beach will thicken as its volatile components are lost. Thickened oil may form tarballs or aggregations that incorporate sand, shell, and other materials into its mass. Tar may be buried to varying depths under the sand. On warm days, both exposed and buried tarballs may liquefy and ooze. Oozing may also serve to expand the size of a mass as it incorporates beach materials.

Oil on the beach may be cleaned up manually, mechanically, or by using both methods. Removal of sand during cleanup is expected to be minimized to avoid significantly reducing sand volumes. Some oil will likely remain on the beach at varying depths and may persist for several years as it slowly biodegrades and volatilizes.

Summary and Conclusion

Should a spill contact a barrier beach, oiling is expected to be light and sand removal during cleanup activities minimized. No significant impacts to the physical shape and structure of barrier beaches and associated dunes are expected to occur as a result of a proposed action.

4.4.3.1.2. Wetlands

The Texas Gulf Coast is comprised of a broad range of saline, brackish, intermediate and fresh marsh wetlands, including wet prairies, forested wetlands, barrier islands, mud flats, estuarine bays, bayous, and riparian wooded areas. Saline and brackish marshes are most widely distributed south of the Galveston Bay area, while the intermediate marshes are the most extensive marsh type east of Galveston Bay. The most extensive wetlands along the Texas coast are located in the Strandplain-Chenier Plain System that runs from eastern Chambers County, Texas, through Vermilion Parish, Louisiana. Coastal Louisiana is made up of two wetland-dominated ecosystems, the Deltaic Plain of the Mississippi River and the Chenier Plain extending from eastern Texas through Vermilion Parish, Louisiana; both are influenced by the Mississippi River. Like Texas, the Louisiana wetlands are comprised of a broad range of wetland habitat including saline, brackish, intermediate, and fresh marsh wetlands; barrier islands; cheniers (ancient beach deposits left stranded in a marsh by the seaward advancement of the marsh); mud flats; estuarine bays; and bayous.

Offshore oil spills associated with a proposed action can result from platform accidents, pipeline breaks, or navigation accidents. Offshore spills are much less likely to have a deleterious effect on vegetated coastal wetlands or seagrasses than inshore spills, which are located inland in the WPA or CPA. Information on oil spills related to a proposed action is provided in Chapter 4.4.1. Information on the risk of spills occurring from a proposed action is provided in Chapter 4.4.1.1.8.

Coastal oil spills can result from storage, barge, or pipeline accidents. Most of these occur as a result of transfer operations. This data indicates that approximately 64 percent of coastal spills occur inland. Coastal spills projected are discussed in Chapter 4.4.1.1.7.

The most likely locations of coastal spills are at pipeline terminals and other shore bases. Spills from support vessels could occur from navigation accidents and will be largely confined in navigation channels and canals. Slicks may quickly spread through the channel by tidal, wind, and traffic (vessel) currents. Spills that damage wetland vegetation fringing and protecting canal banks will accelerate erosion of those once protected wetlands and spoil banks (Alexander and Webb, 1987).

Primary Impacts of Oil Spills

Shoreline types have been rated (via Environmental Sensitivity Indices, (ESI's); Hayes et al., 1980; Irvine, 2000) according to their expected retention of oil and, to some extent, biological effects are believed to be aligned with oil persistence. This is evident in various low-energy environments like salt marshes. Oil has been found or estimated to persist for at least 17-20 years in such environments (Teal et al., 1992; Baker et al., 1993; Burns et al., 1993; Irvine, 2000). In some instances, where there has been further damage due to cleanup activities, recovery has been estimated to take from 8 to 100 years (Baca et al., 1987). Effects on marsh vegetation can be severe (Baca et al., 1987; Baker et al., 1993). The side effects of the depletion of marsh vegetation, which are of special concern to coastal Louisiana and parts of coastal Texas, is the increased erosion. Again, cleanup activities in marshes may accelerate rates of erosion and retard recovery rates, which have been reported to occur from years to decades following a spill.

The critical concentration of oil is that concentration above which impacts to wetlands will be long term and recovery will take longer than two growing seasons, and which causes plant mortality and some permanent wetland loss. Critical concentrations of various oils are currently unknown and are expected to vary broadly for wetland types and wetland plant species. Louisiana wetlands are assumed to be more sensitive to oil contact than elsewhere in the Gulf because of high cumulative stress.

Because OCS-related pipelines traverse wetland areas, pipeline accidents could result in high concentrations of oil directly contacting limited areas of wetland habitats (Fischel et al., 1989). Based on data from Mendelssohn et al. (1990), recovered vegetation is expected to be the ecologically functional equivalent of unaffected vegetation. A reduction in plant density was therefore studied as the principle impact from spills. Mendelsohn and his associates demonstrated that oil could persist in the soil for greater than 5 years if a pipeline spill occurs within the interior of a wetland where wave-induced or tidal flushing is not regular or vigorous.

Numerous investigators have studied the immediate impacts of oil spills on wetland habitats in the Gulf and other wetland habitats similar to those affected by OCS activities, resulting in a range of conclusions. Some of these inconsistencies can be explained by differences in oil concentrations contacting vegetation, kinds of oil spilled, types of vegetation affected, season of year, preexisting stress level of the vegetation, soil types, and numerous other factors. In overview, the data suggest that light-oiling impacts will cause plant dieback with recovery within two growing seasons without artificial replanting. Most impacts to vegetation are considered short term and reversible (Webb et al., 1985; Alexander and Webb, 1987; Lytle, 1975; Delaune et al., 1979; Fischel et al., 1989). Because OCS-related pipelines traverse wetland areas, pipeline accidents could result in high concentrations of oil directly contacting areas of wetland habitats (Fischel et al., 1989) or open waters. The fluid nature of the oil, water levels, weather, and the density of the vegetation would limit the area of interior wetlands contacted by any given spill.

In coastal Louisiana, the critical concentration of oil resulting in long-term impacts to wetlands is assumed to be 0.1 liter per square meter (l/m^2). Concentrations less than this will cause dieback of the aboveground vegetation for one growing season, but limited mortality. Higher concentrations will cause mortality of contacted vegetation, but 35 percent of the affected area will recover within 4 years. Oil will persist in the wetland soil for at least 5 years. After 10 years, permanent loss of 10 percent of the affected wetland area will be expected as a result of accelerated landloss indirectly caused by the spill. If a spill contacts wetlands exposed to wave attack, additional and accelerated erosion will occur, as documented by Alexander and Webb (1987).

Wetlands in Texas occur on a more stable substrate and receive more inorganic sediment per unit of wetland area than wetlands in Louisiana. Texas wetlands have not experienced the extensive alterations caused by rapid submergence rates and extensive canal dredging that affect Louisiana wetlands. The examinations of Webb and colleagues (Webb et al., 1981 and 1985; Alexander and Webb, 1983 and 1985) are used to evaluate impacts of spills in these settings. For wetlands along more stable coasts, such as in Texas, the critical oil concentration is assumed to be 1.0 l/m^2 (Alexander and Webb, 1983). Concentrations below the expected 1.0 l/m^2 will result in short-term, above-ground dieback for one growing season. Concentrations above this will result in longer-term impacts to wetland vegetation, including plant mortality extensive enough to require recolonization.

Using these studies, the following model was developed. For every 50 bbl of oil spilled and contacting wetlands, approximately 2.7 ha of wetland vegetation will experience dieback. Thirty percent of these damaged wetlands are assumed to recover within 4 years; 85 percent within 10 years. About 15 percent of the contacted wetlands are expected to be converted permanently to open-water habitat.

Secondary Impacts of Oil Spills

The cleanup of oil spills in coastal marshes remains a problematic issue because wetlands can be extremely sensitive to the disturbances associated with cleanup activities. Once a marsh is impacted by an oil spill, a decision must be made concerning the best method of cleanup and restoration. Often the best course of action is to let the impacted area(s) recover naturally in order to avoid secondary impacts associated with the cleanup process (McCauley and Harrel, 1981; Long and Vandermeulen, 1983: Getter et al., 1984; Baker et al., 1993; Mendelssohn et al., 1993). Foot traffic and equipment traffic on the marsh surface during cleanup operations are considered secondary impacts that can have significant adverse effects on the recovery of the marsh by trampling vegetation, accelerating erosion, and burying oil into anaerobic soils where it may persist for years (Getter et al., 1984).

Proposed Action Analysis

Figure 4-13 provides the results of the OSRA model that calculated the probability of a spill ≥ 1, 000 bbl occurring offshore as a result of a proposed action in the WPA or CPA and reaching a Gulf Coast county or parish. The probabilities are very small. Most of the counties and parishes are at minimum risk of being contacted; the most frequently calculated probability of a spill contacting their shorelines is less than 0.5 percent. Five counties in Texas and six parishes in Louisiana have a chance of spill contact that is greater than 0.5 percent. For these counties and parishes, the chance of an OCS offshore spill ≥ 1,000 bbl occurring and reaching their shoreline ranges from 1 percent to 8 percent. Plaquemines Parish, Louisiana, has the greatest risk of a spill occurring and contacting its shoreline. In Texas, Matagorda County has the greatest risk of being contacted by a spill occurring offshore as a result of a WPA proposed action. Should such a contact occur, oiling will be very light and spotty with short-term impacts to vegetation. Coastal spills are the greater spill threat to interior wetlands.

Summary and Conclusion

Offshore oil spills resulting from a proposed action are not expected to significantly damage inland wetlands, however, if an inland oil spill related to a proposed action occurs, some impact to wetland habitat would be expected. Although the impact may occur generally over coastal regions, the impact has the highest probability of occurring in the coastal regions, by and large northeast of Galveston County, in the vicinities where WPA oil is handled, and in and around Plaquemines and St. Bernard Parishes in the CPA.

Although the probability of occurrence is low, the greatest threat to wetland habitat is from an inland spill resulting from a vessel accident or pipeline rupture. While a resulting slick may cause minor impacts to wetland habitat and surrounding seagrass communities, the equipment and personnel used to clean up a slick over the impacted area may generate the greatest impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

4.4.3.1.3. Seagrass Communities

Seagrass communities in the WPA are widely scattered beds in shallow, high-salinity coastal lagoons and bays. The most extensive seagrass beds are found in both the Upper and Lower Laguna Madre along the Texas coast, as well as Baffin Bay. In the Texas Laguna Madre, seagrass meadows are the most common submerged habitat type. Seagrass beds in the CPA are restricted to small shallow areas behind barrier islands in Mississippi and Chandeleur Sounds and to smaller, more scattered populations elsewhere. Lower-salinity, seagrass beds are found inland and discontinuously throughout the coastal zone of Louisiana and Mississippi.

Accidental impacts associated with a proposed action that could adversely affect seagrass beds include oil spills associated with the transport and storage of oil (Chapter 4.4.1.1). The degree of impact from oil spills depends on the location of the spill, oil slick characteristics, water depth, currents, and weather. Offshore oil spills that occur in the proposed action areas are much less likely to contact seagrass communities than are inshore spills because the seagrass beds are generally protected by barrier islands, peninsulas, sand spits, and currents.

Some oils can emulsify; suspended particles in the water column will adsorb oil in a slick, decreasing the oil's suspendability and causing some of the oil to be dispersed downward into the water column. Typically, seagrass communities reduce water velocity among the vegetation as well as for a short distance above it. Minute oil droplets, whether or not they are bound to suspended particulate, may adhere to the vegetation or other marine life, be ingested by animals, or settle onto bottom sediments. In all of these situations, oil has a limited life because it will be degraded chemically and biologically. Microbes, which are found in all marine environments, are considered the greatest degraders of oil (Zieman et al., 1984). Because estuaries have a greater suspended particulate load and greater microbial population, oil degrades more rapidly there (Lee, 1977). Oil that penetrates deeply into the sediments is less available for dissolution, oxidation, or microbial degradation. If buried, oil may be detectable in the sediments for 5 years or more, depending upon the circumstances.

The cleanup of slicks in shallow or protected waters (less than 5 ft deep) may be performed using johnboats or booms, anchors, and skimmers mounted on boats or shore vehicles. Personnel assisting in oil-spill cleanup in water shallower than 3-4 ft may readily wade through the water to complete their tasks (Chapter 4.4.1.1).

Proposed Action Analysis

The probability of one or more oil spills ≥1,000 bbl occurring due to a proposed action ranges from 34 to 63 percent in the CPA and from 19 to 33 percent in the WPA, for the range of resources estimated to be developed) (Chapter 2.3.1 for the CPA and Chapter 2.4.1 for the WPA). The probabilities of a spill ≥1,000 bbl occurring and contacting environmental features are described in Chapter 4.4.1.1. The total estimated number of spill events over the 40-year life of a proposed action is 956-2,277 offshore spills for a typical proposed action in the CPA and 473-910 offshore spills for a typical proposed action in the WPA (Chapter 4.4.1.1). Spills that could occur in coastal waters from proposed action support operations are estimated at 51-123 spills for a proposed action in the CPA and 26-52 for a proposed action in the WPA.

The risk of an offshore spill ≥1,000 bbl occurring and contacting coastal counties and parishes was calculated by MMS's oil-spill trajectory model. Counties and parishes are used as an indicator of the risk of an offshore spill reaching sensitive coastal environments. Figure 4-13 provides the results of the OSRA model that calculated the probability of a spill ≥1, 000 bbl occurring offshore as a result of a proposed action in the CPA or WPA and reaching a Gulf Coast county or parish. The probabilities are very small. Most of the counties and parishes are at minimum risk of being contacted; the most frequently calculated probability of a spill contacting their shorelines is less than 0.5 percent. Five counties in Texas and six parishes in Louisiana have a chance of spill contact that is greater than 0.5 percent. For these counties and parishes, the chance of an OCS offshore spill ≥1,000 bbl occurring and reaching their shoreline ranges from 1 percent to 8 percent. Plaquemines Parish, Louisiana, has the greatest risk of a spill occurring and contacting its shoreline. In Texas, Matagorda County has the greatest risk of being contacted by a spill occurring offshore as a result of a WPA proposed action.

The more inland seagrass beds are generally protected from offshore spills by barrier islands, shoals, shorelines, and currents. These beds are generally more susceptible to contact by inshore spills, which have a low probability of occurrence. Inshore vessel collisions may release fuel and lubricant oils and pipeline ruptures may release crude and condensate oil. In either case, seagrass beds grow below the water surface. In this region of the Gulf, they remain submerged due to the micro-tides that occur there. Their regenerative roots and rhizomes are buried in the water bottom, where they are further protected (Chapter 3.2.1.3). Should an oil slick pass over these seagrass communities, damage would occur if an unusually low tide were to occur, causing contact between the two. A more damaging scenario would be that a slick might pass over and remain over a submerged bed of vegetation in a protected embayment during typical fair-weather conditions. This would reduce light levels in the bed. If light reduction continues for several days, chlorophyll content in the leaves will be reduced (Wolfe et al., 1988), causing the grasses to yellow and reducing their productivity. Shading by an oil slick of the sizes described should not last long enough to cause mortality, depending upon the slick thickness, currents, weather, and the nature of the embayment. In addition, a slick that remains over seagrass beds in an embayment also will reduce or eliminate oxygen exchange between the air and the water of the embayment. Oxygen depletion is a serious problem for seagrasses (Wolfe et al., 1988). If currents flush little oxygenated water between the embayment and the larger waterbody and if the biochemical oxygen demand (BOD) is high, as it would be in a shallow water bed of vegetation, and then enhanced by an additional burden of oil, the grasses and related epifauna will be stressed and perhaps suffocated. In this situation, the degree of suffocation will depend upon the reduced oxygen concentration and duration of those conditions. Oxygen concentrations and their duration depend upon currents, tides, weather, temperature, percentage of slick coverage, and BOD.

The Galveston/Houston/Texas City area has the greatest risk of experiencing coastal spills related to a proposed action in the WPA and the Deltaic Plain area of Louisiana has the highest risk in the CPA (Chapter 4.4.1.1).

Should weather conditions or currents increase water turbulence sufficiently, a substantial amount of oil from the surface slick will be dispersed downward into the water column. Suspended particles in the water column will adsorb to the dispersed oil droplets as well as to some of the oil in the sheen. Typically, submerged vegetation reduces water velocity among the vegetation and enhances sedimentation. Typically, this will not cause long-term or permanent damage to the seagrass communities. Some dieback of leaves would be expected for one growing season. No permanent loss of seagrass habitat is projected to result from the spill unless an unusually low tidal event allows direct contact between the slick and the vegetation. The most probable danger under these more likely circumstances is a reduction, for up to 2 years, of the diversity or population of epifauna and benthic fauna found in seagrass beds.

No significant burial of the oil is expected to occur from any one spill. Oil measured at some depth usually means the area is impacted by chronic oil contamination, new sediments are spread over the area, or heavy foot or other traffic works the oil into the bottom sediment. The cleanup of slicks that settle over seagrass communities in shallow waters may damage the areas where props, anchors, boat bottoms, treads, wheels, trampling, and dragging booms crush or dig up plants.

Summary and Conclusion

Should a spill ≥1,000 bbl occur offshore from activities resulting from a proposed action, the seagrass communities with the highest probabilities of contact within 10 days would be those located within Matagorda County, Texas, for a proposed action in the WPA and Plaquemines Parish, Louisiana, for a proposed action in the CPA.

Because of the location of most submerged aquatic vegetation, inshore spills pose the greatest threat to them. Such spills may result from either vessel collisions that release fuel and lubricants or from pipelines that rupture. If an oil slick settles into a protective embayment where seagrass beds are found, shading may cause reduced chlorophyll production; shading for more than about 2 weeks could cause thinning of leaf density. Under certain conditions, a slick could reduce dissolved oxygen in an embayment and cause stress to the bed and associated organisms due to reduced oxygen conditions. These light and oxygen problems can correct themselves once the slick largely vacates the embayment and light and oxygen levels are returned to pre-slick conditions.

Increased water turbulence due to storms or vessel traffic will break apart the surface sheen and disperse some oil into the water column, as well as increase suspended particle concentration, which will adsorb to the dispersed oil. Typically, these situations will not cause long-term or permanent damage to the seagrass beds, although some dieback of leaves is projected for one growing season. No permanent loss of seagrass is projected to result from oil contact, unless an unusually low tidal event allows direct contact between the slick and vegetation. The greatest danger under the more probable circumstances is a reduction, for up to 2 years, of the diversity or population of epifauna and benthic fauna found in seagrass beds.

Although the probability of their occurrence is low, the greatest threat to inland, seagrass communities would be from an inland spill resulting from a vessel accident or pipeline rupture. Although a resulting slick may cause minor impacts to the bed, equipment and personnel used to clean up a slick over shallow seagrass beds may generate the greatest direct impacts to the area. Associated foot traffic may work oil farther into the sediment than would otherwise occur. Scarring may occur if an oil slick is cleaned up over a shallow submerged aquatic vegetation bed where vessels, booms, anchors, and personnel on foot would be used and scar the bed. Close monitoring and restrictions on the use of bottom-disturbing equipment would be needed to avoid or minimize those impacts.

4.4.3.2. Impacts on Sensitive Offshore Resources

4.4.3.2.1. Live Bottoms (Pinnacle Trend)

A number of OCS-related factors may cause adverse impacts on the pinnacle trend communities and features. Damage caused by oil spills, blowouts, anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, produced-water discharges, and the disposal of domestic and sanitary wastes can cause the immediate mortality of live-bottom organisms or the alteration of sediments to the point that recolonization of the affected areas may be delayed or impossible.

Oil spills have the potential to foul benthic communities and cause lethal or sublethal effects on live-bottom organisms. Oil from a surface spill can be driven into the water column, with measurable amounts to a 20-m depth. Yet, at this depth, the spilled oil would be at concentrations several orders of magnitude lower than the amount shown to have an effect on marine organisms. Subsurface oil spills from pipeline ruptures would have a greater potential to bring high concentrations of oil in contact with the biota of the pinnacles. The actual concentrations of subsurface-released oil reaching this biota would depend on the severity and the proximity of the spill and on the speed and direction of prevailing subsurface currents.

Blowouts have the potential of resuspending considerable amounts of sediment and releasing hydrocarbons into the water column. This would pose a threat to the biota of pinnacles, particularly when the disturbance is immediately adjacent to the resource. Oil or condensate may be present in the reservoir and may also be injected into the water column. The bulk of the sediments would be redeposited within a few thousand meters of the blowout site. The sedimentation caused by a severe subsurface blowout occurring within 400 m of a pinnacle community could result in the smothering of biota. Blowout incidents do not necessarily result in sediment releases or resuspension.

Proposed Action Analysis

The pinnacles in the Central Gulf of Mexico are located in the Main Pass and Viosca Knoll lease areas off Mississippi and Alabama within offshore Subareas C0-60 and C60-200; there are no known pinnacle features found in the Western Gulf. Table 4-2 provides information regarding the level of OCS-related activities in the vicinity of the pinnacles including the number of projected wells, production structures, pipeline lengths, and blowouts. The majority of the exploratory/delineation wells and production structures will not be located in the pinnacle trend area, based on an MMS analysis.

Any surface oil spill resulting from a proposed action would likely have no impact on the biota of the pinnacle trend because the crests of these features are much deeper than 20 m.

All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (Chapter 4.4.1.1.5.4), and thus not impact pinnacles. The risk for weathering components from a surface slick reaching pinnalces in any measurable concentrations would be very small. Such natural containment and dispersion of oil, as well as the widespread nature of the biota, would limit the severity and the extent of the area impacted by subsurface spills. A subsurface pipeline oil spill ($\geq$1,000 bbl) could result in the most deleterious impacts on the biota of pinnacles, particularly if the oil impinges directly on the pinnacles. Yet, the biota of the pinnacles would probably recover once the oil is cleared. There are no data to date that reveal the effects or recovery time associated with oil spills on pinnacle trend features.

There are 1-2 projected blowouts associated with a proposed action in the CPA (Table 4-2); however, any activity of a debilitating nature would be well away from the pinnacles based on the implementation of the proposed Live Bottom Stipulation, which restricts the distance wells can be from a pinnacle feature.

Summary and Conclusion

With implementation of the Live Bottom Stipulation, there would be few operations in the vicinity of the pinnacles as a result of a proposed action. Because of this and the small size and dispersed nature of many of the features, impacts from accidental events as a result of a proposed action are expected to be infrequent. No community-wide impacts are expected. Potential impacts from blowouts would be minimized because of the proposed Live Bottom Stipulation and the low levels of oil and gas activities anticipated in the area. Oil spills would not be followed by adverse impacts (e.g., high elevated decrease in live cover) because of the depth of the features and dilution of spills (by currents and the quickly rising oil). The frequency of impacts on the pinnacles would be rare, and the severity should be slight because of the widespread nature of the features.

Effects of the Proposed Action without the Proposed Stipulation

Activities resulting from a proposed action without the protection of the proposed biological stipulation could have an extremely deleterious impact on portions of the pinnacle trend. Potential impacts on the pinnacle trend, live-bottom areas from a proposed action, and blowouts would be infrequent because of the low projected levels of OCS activities. In addition, the widespread occurrence of these pinnacles would further restrain these impacts.

4.4.3.2.2. Live Bottoms (Topographic Features)

The topographic features of the Western and Central Gulf sustaining sensitive offshore habitats are listed and described in Chapters 4.2.1.2.1 and 4.3.1.2.1, respectively. Please refer to Chapters 2.3.1.3.1 and 2.4.1.3.1 for a complete description and discussion of the proposed Topographic Features Stipulations.

Disturbances resulting from the proposed actions, including oil spills and blowouts, have the potential to disrupt and alter the environmental, commercial, recreational, and aesthetic values of topographic features of both the CPA and WPA.

Oil spills potentially affecting topographic features and their biological communities could result from surface and seafloor spills. Surface oil spills may occur as a result of platform or tanker spills. A tanker accident, pipeline rupture, or well blowout could cause spills at the seafloor. Both surface and subsurface spills could result in a steady discharge of oil over a long period of time. The depth to which topographic features rise in the northern Gulf of Mexico (to within 15 m [49 ft] of the sea surface) and their distance from shore (more than 103 km (64 mi)) should protect any of the tropical reef plant and animal species they harbor from surface oil slicks. Oil from a surface spill can be driven into the water column; measurable amounts have been documented down to a 10-m depth, although modeling exercises have indicated such oil may reach a depth of 20 m. At this depth, the oil is found at concentrations several orders of magnitude lower than the amount shown to have an effect on corals (Lange, 1985; McAuliffe et al., 1975 and 1981; Knap et al., 1985). Because the crests of topographic features in the northern Gulf are found below 10 m, no concentrated oil from a surface spill could reach their sessile biota.

A subsurface oil spill could reach a topographic feature and would have the potential of considerably impacting the local biota contacted by the oil. Such impacts on the biota may have severe and long-lasting consequences, including loss of habitat, biodiversity, and live coverage; destruction of hard substrate; change in sediment characteristics; and reduction or loss of one or more commercial and recreational fishery habitats.

Subsurface spills could result in the formation and settling of oil-saturated material, and oil-sediment particles could come into contact with living coral tissue; however, a subsurface spill should rise to the surface, and any oil remaining at depth would probably be swept clear of the banks by currents moving around the banks (Rezak et al., 1983). Should any of the oil come in contact with adult sessile biota, effects would be primarily sublethal, with few incidences of actual coral mortality. The sublethal effects could be long lasting and affect the resilience of coral colonies to natural disturbances (e.g., elevated water temperature and diseases) (Jackson et al., 1989).

Continental Shelf Associates (CSA) (1992b) modeled the potential impacts of a pipeline larger than the one estimated to occur from a proposed action (10,000 bbl spilled over 2-7 days) to maximize the estimates of dispersed oil concentrations reaching four topographic features (East Flower Garden, West Flower Garden, MacNeil, and Rankin Banks). Referencing their model, CSA estimated that the worst-case concentrations of crude oil reaching the four banks would be sublethal to the corals and much of the other biota present.

CSA (1994) also investigated the potential effects of oil spilled from a platform-pipeline complex proposed for installation near the Flower Garden Banks using a range of spill scenarios that included the most likely one estimated for this EIS. Twenty-four different spill scenarios from two platforms and three pipelines were modeled. The modeling resulted in the maximum concentration of oil reaching the East Flower Garden Bank. The most damaging scenarios resulting from this modeling effort included a 2,617-bbl/day and a 1,000-bbl/day spill, both lasting 30 days and both occurring at the same platform location. Although the model estimated no acute toxicity to reef coral colonies, the values were within the range of acute toxicity to embryos and larvae of fish, corals, and other invertebrates.

In 1996, the Regional Response Team for Region VI, which includes the coastal states of Texas and Louisiana, approved the use of chemical dispersants on surface oil spills in exclusion zones of the northern Gulf such as the Flower Garden Bank National Marine Sanctuary (revised Federal On-Scene Coordinator Preapproved Dispersant Use Manual-Region VI Oil and Hazardous Substances Pollution Contingency Plan). Depending on the toxicity of the dispersant used; tradeoffs to responding to surface oil spills using dispersants include impacts on pelagic organisms and on the adult as well as the larval stages of benthic organisms on topographic features. Gulf of Mexico oil, however, is usually dispersed with Corexit 9527. Considering the depth of the crests of topographic features (greater than 15 m), the dilution by seawater, and the added dispersion by currents, any dispersed oil that reaches the benthic dwellers would be expected to be at very low concentrations (less than 1 ppm). Such low oil concentrations would not be life threatening to larval or adult stages at depth (Fucik et al., 1994). Dispersants would probably not be approved during coral spawning periods (e.g., August-September for major reef-building species) (Gittings et al., 1992 and 1994) in order to limit the impacts of oil pollution on the near-surface portion of the water column.

Dodge et al. (1995) observed that, compared to a control site and to a site exposed to oil alone, a 2-m deep reef environment off the Caribbean coast of Panama was negatively impacted by dispersed oil (probably at a concentration greater than 10 ppm) as it reduced the cover of all reef organisms as much as 40 percent, particularly that of live substrate-binding sponges. Ten years later, the same impacted site regained or even exceeded the pre-impact live cover. Guzman et al. (1991), however, found that a prolonged exposure to oil alone, as well as chronic exposure to oil, greatly depressed both the coverage and growth rates of reef corals within a 6-m-deep reef area along the Caribbean coast of Panama. Also, Bak (1987) showed that reef corals on the shallow (4-6 m) southwestern shore of Aruba (Netherlands Antilles) had incurred mortality, decreases in live coral cover by as much as 70 percent, reductions of species diversity (as many as 10 out of 24 species missing), and reef structural changes over a 10- to 15-km downstream shore length as a result of the exposure to long-term (1929-1985) chronic oil spills, dispersed oil, and refinery discharges. *Diploria strigosa* appeared to be more resilient to oil pollution than other reef coral species because its cover did not seem to be affected by the pollutants. Therefore, it has been shown that oil, as well as dispersed oil, has the potential to greatly impact reef coral communities, particularly when the exposure is chronic and long term. The time needed for the recovery of such impacted reefs could be as long as 30 years and would depend on the frequency and severity of any future human-made and natural disturbances.

The proposed Topographic Features Stipulations would preclude drilling in a No Activity Zone to prevent adverse effects from nearby drilling on topographic features. Oil spills originating outside the No Activity Zones would be dispersed to diluted concentrations in the water column prior to reaching topographic features (CSA, 1992b and 1994).

Oil or gas well blowouts are possible occurrences in the OCS. Benthic communities exposed to large amounts of resuspended sediments following a subsurface blowout could be subject to sediment suffocation, exposure to resuspended toxic contaminants, and reduced light attenuation. Should oil or condensate be present in the blowout flow, liquid hydrocarbons could be an added source of negative impact on the benthic community (low-molecular-weight gases would dissolve in the water column until saturation is reached). The amounts of oil or sediments that settle vary as a function of the specific gravity of the oil or the sediments, and their dilution, dispersion, and response to currents (Brooks and Bernard, 1977). In most cases, currents should sweep the impact-producing materials around a topographic feature rather than deposit them on top of it (Rezak et al., 1983). The bulk of the blowout materials would be redeposited within a few thousand meters of their source; sand would be redeposited within 400 m of the blowout site. The extent of the damage incurred by the benthic community would depend on the amount and duration of exposure to sediments or oil. The consequences of a blowout directly on or near a topographic feature could last more than 10 years. Since the proposed stipulations would preclude drilling in the No Activity Zone, most adverse effects on topographic features from blowouts would likely be prevented.

Proposed Action Analysis

All of the 42 topographic features (shelf edge banks, low-relief banks, and south Texas banks) in the CPA and WPA are found in waters less than 200 m deep. They represent a small fraction of the continental shelf area in the CPA and WPA. The fact that the topographic features are widely dispersed, combined with the probable random nature of oil-spill locations, serves to limit the extent of damage from any given oil spill to any one of the sensitive areas.

The proposed Topographic Features Stipulations (discussed in Chapters 2.3.1.3.1 and 2.4.1.3.1) will assist in preventing most of the potential impacts from oil and gas operations, including accidental oil spills and blowouts, on the biota of topographic features. However, operations outside the No Activity Zones (including blowouts and oil spills) may still affect topographic features. The projected oil-spill scenarios related to the proposed actions for the CPA and WPA (projections are based on a 40-year life for any one lease sale) are found in Table 4.4.3.1.2.

Approximately 1-2 blowouts are projected to occur in waters less than 200 m deep in the CPA and zero blowouts are projected in the WPA during activities resulting from the proposed actions. With the application of the proposed stipulations, none of these blowouts should occur within the No Activity Zones. Furthermore, blowouts outside the No Activity Zones are unlikely to impact the biota of topographic features.

Some offshore resources are at a minimal risk of being contacted should a spill originate in the CPA and WPA as a result of a proposed action. There is a 2.0-5.0 percent and 0.5-1.0 percent likelihood that a spill would reach the area of the Flower Garden Banks National Marine Sanctuary from the WPA or CPA, respectively. The East Flower Garden Bank rises to within 16 m of the sea surface, and the West Flower Garden Bank to within 18 m. Any oil that might be driven to 16 m or deeper would probably be at concentrations low enough to avoid or substantially reduce any impact; therefore, a surface oil spill would probably not impact the biota of the Flower Garden Banks or the other topographic features. In addition to the Flower Garden Banks, there are several other feature locations with a minimal percent probability of an accidental oil spill occurring as a result of a proposed action reaching their locations:

Resource Location	WPA Range (Low/High)* % Probability	CPA Range (Low/High)* % Probability
Texas State Offshore Waters	5-8	1-1
Flower Garden Banks	2-4	<0.5-1
Stetson Bank	1-2	<0.5
Louisiana (E) State Offshore Waters	<0.5	2-4
Louisiana (W) State Offshore Waters	1-2	9-19
Sonnier Bank	1-1	1-2

* Low = low oil-volume estimate.
High = high oil-volume estimate.

A subsurface spill originating from a pipeline rupture or a blowout may cause sessile biota of topographic features to be impacted by oil, potentially causing sublethal and lethal effects. Projections of persistence for a pipeline spill occurring during the summer months 50 mi off Louisiana in 200 ft of water and for a winter spill occurring 65 mi off Texas in 130 ft of water are listed in Tables 4.SpillCPAWeathering and 4.SpillWPAWeathering. The Topographic Features Stipulations would limit the potential impact of such occurrences by keeping the sources of such adverse events geographically removed from the sensitive biological resources of topographic features.

Summary and Conclusion

The proposed Topographic Features Stipulations will assist in preventing most of the potential impacts on live-bottom communities from blowouts and surface and subsurface oil spills. Recovery from incidences of impacts from blowouts would take place within 10 years.

Contact with spilled oil would cause lethal and sublethal effects in benthic organisms. The oiling of benthic organisms is not likely because the proposed Topographic Features Stipulations would keep subsurface sources of spills away from the immediate vicinity of topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for adult sessile biota, including coral colonies in the case of the Flower Garden Banks, and there would be limited incidences of mortality. The recovery of harmed benthic communities could take more than 10 years.

Effects of the Proposed Actions without the Proposed Stipulations

The topographic features and associated coral reef biota of the Central and Western Gulf could be adversely impacted by oil and gas activities resulting from the proposed actions should they be unrestricted by the absence of the proposed Topographic Features Stipulations. This would be particularly true should operations occur directly on top of or in the immediate vicinity of otherwise protected topographic features.

The area within the No Activity Zones would probably be the areas of the topographic features most susceptible to adverse impacts if oil and gas activities are unrestricted by the Topographic Features Stipulations or project-specific mitigating measures. These impacting factors would include blowouts, surface oil spills, and subsea oil spills. Potential impacts from routine activities resulting from the proposed actions are discussed in Chapters 4.2.1.2.1 and 4.3.1.2.1. Oil spills as well as routine activities have the potential to considerably alter the diversity, cover, and long-term viability of the reef biota found within the No Activity Zone. In most cases, recovery from disturbances would take 10 years or more. Indeed, disturbances, including oil spills and blowouts, would alter benthic substrates and their associated biota over areas possibly ranging from tens to thousands of square meters per event. In the unlikely event of a blowout, sediment resuspension potentially associated with oil could cause adverse turbidity and sedimentation conditions. In addition to affecting the live cover of a topographic feature, a blowout could alter the local benthic morphology, thus irreversibly altering the reef community. Oil spills (surface and subsea) could be harmful to the local biota should the oil have a prolonged or recurrent contact with the organisms.

Therefore, in the absence of the Topographic Features Stipulations, the proposed actions could cause long-term (10 years or more) adverse impacts to the biota of the topographic features, located in most cases on those portions of the topographic features that are in 85 m and less water depth.

4.4.3.2.3. Chemosynthetic Deepwater Benthic Communities

Accidental events that could impact chemosynthetic communities are limited primarily to blowouts. A blowout at the seafloor could create a crater and could resuspend and disburse large quantities of bottom sediments within a 300-m radius from the blowout site, thus organisms located within that distance. The application of avoidance criteria for chemosynthetic communities required by NTL 2000-G20 should preclude the impact of a blowout to a distance of 457 m (1,500 ft).

Impacts to chemosynthetic communities from any oil released would be a remote possibility. Release of hydrocarbons associated with a blowout should not present an possibility for impact to chemosynthetic communities located a minimum of 457 m (1,500 ft) from well sites. All known reserves in the Gulf to date have specific gravity characteristics that would preclude oil from sinking immediately after release at a blowout site. The potential for weathered components from a surface slick reaching a chemosynthetic community in any measurable volume would be very small.

Oil and chemical spills are not considered to be a potential source of measurable impacts on chemosynthetic communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink. All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (Chapter 4.4.1.1.5.4), and thus not impact the benthos. The risk for weathering components from a surface slick reaching the benthos in any measurable concentrations would be very small.

There is some reason to believe the presence of oil may not have an impact in the first place because these communities live among oil and gas seeps; however, natural seepage is very constant and at very low rates as compared to the potential volume of oil released from a blowout or pipeline rupture. All seep organisms also require unrestricted access to oxygenated water at the same time as exposure to hydrocarbon energy sources.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type), although it may reappear relatively quickly once the process begins, as in the case of a mussel community. Tube-worm communities may be the most sensitive of all communities because of the combined requirements of hard substrate and active hydrocarbon seepage. Mature tube-worm bushes have been found to be several hundred years old. There is evidence that substantial impacts on these communities would permanently prevent reestablishment, particularly if hard substrate required for recolonization was buried.

Proposed Action Analysis

For water depths greater than 200 m, 0-3 blowouts are estimated in the CPA and 0-1 blowouts are estimated in the WPA. The application of avoidance criteria for chemosynthetic communities required by NTL 2000-G20 should preclude the impact of a blowout to a distance of 457 m (1,500 ft), which is beyond the distance of expected benthic disturbance. Resuspended bottom sediments transported by near-bottom currents could reach chemosynthetic comminutes located beyond 457 m and potentially impact them by burial or smothering.

The risk of various sizes of oil spills occurring in the CPA or WPA are presented in Table 4-44. The probability of oil in any measurable concentration reaching depths of 400 m or greater is very small.

Summary and Conclusion

Chemosynthetic communities could be susceptible to physical impacts from a blowout depending on bottom-current conditions. The provisions of NTL 2000-G20 greatly reduce the risk of these physical impacts by requiring avoidance of potential chemosynthetic communities identified on required geophysical survey records or by requiring photodocumentation to establish the absence of chemosynthetic communities prior to approval of the structure emplacement.

Studies indicate that periods as long as hundreds of years are required to reestablish a seep community once it has disappeared (depending on the community type). There is evidence that substantial impacts on these communities would permanently prevent reestablishment, particularly if hard substrate required for recolonization was buried.

Potential accidental impacts from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities located at more than 1,500 ft away from a blowout could experience minor impacts from resuspended sediments.

4.4.3.2.4. Nonchemosynthetic Deepwater Benthic Communities

A blowout at the seafloor could create a crater and could resuspend and disburse large quantities of bottom sediments within a 300-m radius from the blowout site, thus destroying any organisms located within that distance. Physical disturbance or destruction of a limited area of benthos or to a limited number of megafauna organisms, such as brittle stars, sea pens, or crabs, would not result in a major impact to the deepwater benthos ecosystem as a whole.

Oil and chemical spills are not considered to be a potential source of measurable impacts to nonchemosynthetic deepwater benthic communities because of the water depths at which these communities are located. Oil spills at the surface would tend not to sink. All evidence to date indicates that accidental oil discharges that occur at the seafloor from a pipeline or blowout would rise in the water column, surfacing almost directly over the source location (Chapter 4.4.1.1.5.4), and thus not impact the benthos. The risk for weathering components from a surface slick reaching the benthos in any measurable concentrations would be very small.

Under the current review procedures for chemosynthetic communities, carbonate outcrops (surface anomaly on 3-D seismic survey data) are targeted as one possible indication that chemosynthetic seep communities are nearby. Any unique nonchemosynthetic communities that may be associated with carbonate outcrops or other topographical features would be avoided via this review along with the chemosynthetic communities. Typically, all areas suspected of being hard bottom are avoided as a potential geological hazard for any well sites. Any proposed activity in water depth greater than 400 m would automatically trigger the NTL 2000-G20 evaluation described above.

Proposed Action Analysis

For water depths greater than 200 m, 0-3 blowouts are estimated in the CPA and 0-1 blowouts are estimated in the WPA.

The risk of various sizes of oil spills occurring in the CPA or WPA are presented in Table 4-44. The probability of oil in any measurable concentration reaching depths of 400 m or greater is very small.

Summary and Conclusion

Accidental events resulting from the proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities. Some impact to benthic communities would occur as a result of impact from an accidental blowout. Megafauna and infauna communities at or below the sediment/water interface would be impacted by the physical disturbance of a blowout or by burial from resuspended sediments. Even in situations where substantial burial of typical benthic communities occurred, recolonization from populations from neighboring substrate would be expected over a relatively short period of time for all size ranges of organisms, in a matter of hours to days for bacteria and probably less than one year for most all macrofauna species.

Deepwater coral habitats and other potential hard-bottom communities not associated with chemosynthetic communities appear to be very rare. These unique communities are distinctive and similar in nature to protected pinnacles and topographic features on the continental shelf. Any hard substrate communities located in deep water would be particularly sensitive to impacts. Impacts to these sensitive habitats could permanently prevent recolonization with similar organisms requiring hard substrate, but adherence to the provisions of NTL 2000-G-20 should prevent all but minor impacts to hard-bottom communities beyond 454 m (1,500 ft).

The proposed actions are expected to cause little damage to the ecological function or biological productivity of the widespread, typical, deep-sea benthic communities.

4.4.3.3. Impacts to Water Quality

Accidental events that could impact water quality include spills of oil, refined hydrocarbons, or chemicals. An accidental spill of oil could occur from leakage, a pipeline break, or a blowout. Water quality is altered and degraded by oil spills through the increase of petroleum hydrocarbons (alkanes, cycloalkanes, and aromatic compounds) and their various transformation/degradation products. The extent of impact from a spill depends on the behavior and fate of oil in the water column (e.g., movement of oil and rate and nature of weathering), which, in turn, depends on oceanographic and meteorological conditions at the time.

The National Academy of Sciences (NRC, 1985) and Boesch and Rabalais (1987) have reviewed the fate and effects of spilled oil. In general, the impacts to water quality are greatest when a spill occurs in a confined area where it persists for a long period of time. In an environment where the oil can be dispersed or diluted, the impacts are reduced. Very little information is available about the effects of an oil spill on water quality because most studies have focused on the spilled oil and its dissipation and not on the surrounding water and its alteration. Also, spills of opportunity are few and difficult to sample on short notice. The evaluation of impacts from a large spill on water quality are based on qualitative and speculative information.

There are very few oil spills from blowouts.

Accidental riser disconnects could result in the release of large quantities of drilling fluids and are of particular concern when synthetic-based drilling fluids (SBF) are in use. The use of SBF occurs primarily in deep water where large volumes can be released. Three recent riser disconnects have resulted in the discharge of 600-800 bbl of SBF per incident.

4.4.3.3.1. Coastal Waters

The ability of coastal waters to assimilate spilled oil is affected by the shallowness of the environment. Large volumes of water are not available to dilute suspended oil droplets and dissolved constituents. Since oil does not mix with water and is usually less dense, most of the oil forms a slick at the surface. Small droplets in the water may adhere to suspended sediment and be removed from the water column. Oil contains toxic aromatic compounds such as benzene, toluene, xylenes, naphthalenes, and polynuclear aromatic hydrocarbons, which are soluble to some extent in water. The effect of these compounds on water quality depends on the circulation in the coastal environment, the composition of the spilled oil, and the length of time the oil is in contact with the water. Oil may also penetrate sand on the beach or be trapped in wetlands, where it can be re-released into the water some time after the initial spill.

4.4.3.3.2. Marine Waters

The Gulf of Mexico has numerous natural hydrocarbon seeps as discussed in Chapters 3.1.2.2 and 4.1.3.4. The marine environment can be considered adapted to handling small amounts of oil released over time. Most of the oil spills that may occur as a result of a proposed action are expected to be ≤1 bbl (Table 4-44).

An oil spill ≥1,000 bbl at the water surface may result from a platform accident. Subsurface spills would occur from pipeline failure or a wellhead blowout. Most of the oil from a subsurface spill would likely rise to the surface and would weather and behave similarly to a surface spill, dependent upon a number of factors, particularly the characteristics of the released oil and oceanographic conditions. However, some of the subsurface oil may also get dispersed within the water column, as in the case of the *Ixtoc I* seafloor blowout. Evidence from a recent experiment in the North Sea indicates that oil released during a deepwater blowout would quickly rise to the surface and form a slick (Johansen et al., 2001). Impacts from a deepwater oil spill would occur at the surface where the oil would be mixed into the water and dispersed by wind waves.

Once the oil enters the ocean, a variety of physical, chemical, and biological processes act to disperse the oil slick, such as spreading, evaporation of the more volatile constituents, dissolution into the water column, emulsification of small droplets, agglomeration sinking, microbial modification, photochemical modification, and biological ingestion and excretion. The water quality of marine waters would be temporarily affected by the dissolved components and small oil droplets that do not rise to the surface or are mixed down by surface turbulence. Dispersion by currents and microbial degradation remove the oil from the water column or dilute the constituents to background levels.

The most likely oil-spill scenario for spills ≥1,000 bbl is a 4,600-bbl spill from a pipeline break that leaks for 12 hr. For a likely spill in the CPA, after three days, approximately 1 percent of the oil is expected to naturally disperse and about 45 percent is expected to be chemically dispersed. For the WPA, by two days, approximately 42 percent would be dispersed and 1,040 bbl chemically dispersed. The volume of oil is small relative to the amount of oil that enters the Gulf of Mexico through natural seeps; however, this represents a large quantity over a short period of time. Because the Gulf is a large body of water, the toxic constituents, such as benzene, toluene, xylene, and naphthalene, are expected to rapidly disperse to sublethal concentrations.

Chemical Spills

A recent study of chemical spills from OCS activities determined that accidental releases of zinc bromide and ammonium chloride could potentially impact the marine environment (Boehm et al., 2001). Both of these chemicals are used for well treatment or completion and are not in continuous use; thus, the risk of a spill is small. Most other chemicals are either nontoxic or used in such small quantities that a spill would not result in measurable impacts. Zinc bromide is of particular concern because of the toxic nature of zinc. Close to the release point of an ammonium chloride spill, the ammonia concentrations could exceed toxic levels for time scales of hours to days. Additional information on the degradation of ammonia in seawater is needed for a better evaluation of the impacts.

Accidental Releases of Drilling Fluids

The effects of the accidental release of a large volume of SBF (e.g., from an accidental riser disconnect) have not been studied. Because of the specific gravity of SBF, such drilling fluids would be expected to sink to the seafloor in the area immediately at and adjacent to the release site. Localized anoxic conditions at the seafloor would be expected to occur. This would be short term, lasting until the SBF decomposed.

Blowouts

For a proposed action in the WPA, 1-2 blowouts are expected to occur during the life of the leases; 2-4 blowouts are expected to be associated with activities resulting from a proposed action in the CPA. Blowouts may result in localized suspension of sediments, thus affecting water quality temporarily. Results from a recent simulated experiment of a deepwater blowout indicated that the oil rose from 850 m to the surface in approximately one hour.

Since blowouts are rare events and of short duration, potential impacts to marine water quality are not expected to be significant.

Summary and Conclusion

Smaller spills (<1,000 bbl) are not expected to significantly impact water quality in marine and coastal waters. Larger spills, however, could impact water quality especially in coastal waters. Chemical spills, the accidental release of SBF, and blowouts are expected to have temporary localized impacts on water quality.

4.4.3.4. Impacts on Air Quality

The accidental release of hydrocarbons or chemicals from OCS-related activities will cause the emission of air pollutants. Some of these pollutants are precursors to ozone, which is formed by complex photochemical reactions in the atmosphere. Accidents, such as oil spills and blowouts, are a source of emissions related to OCS operations. Typical emissions from OCS accidents consist of hydrocarbons; only fires produce a broad array of pollutants, including all NAAQS-regulated primary pollutants. The criteria pollutants considered here are nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur oxides (SO_x), volatile organic chemicals (VOC), and particulate matter less than 10 microns in size (PM_{10}).

An oil spill (assumed size of 4,600 bbl) from a pipeline break during the summer at a location 50 mi off Louisiana was modeled for a period of 10 days (Table 4-45). An oil spill (assumed size of 4,600 bbl) from a pipeline break during the winter at a location 65 mi off Texas was modeled for a period of 10 days (Table 4-46). At the end of 10 days 30% of the CPA slick and 31% of the WPA slick were lost due to evaporation. The contribution of oil-spill emissions to the total VOC emission is small, about 0.5 percent.

Blowouts are accidents related to OCS oil and gas activities and are defined as an uncontrolled flow of fluids from a wellhead or wellbore. The air pollutant emissions from blowouts depend on the amount of oil and gas released, the duration of the accident, and the occurrence or not of fire during the blowout. The duration of most blowouts is short duration, and half of blowouts lasted less than half a day. Blowouts may result in the release of synthetic drilling fluid or loss of oil. From 1992 to 2000, less than 10 percent of blowouts have resulted in spilled oil, which ranged from 1.5 to 200 bbl. An estimated 2-4 blowouts could occur from activities resulting from a proposed action in the CPA and 1-2 blowouts from a proposed action in the WPA.

The presence of hydrogen sulfide (H_2S) within formation fluids occurs sporadically throughout the Gulf of Mexico OCS, which may be released during an accident. There has been some evidence that petroleum from deepwater plays contain significant amounts of sulfur. Encounters with H_2S in oil and gas operations have caused injury and death throughout the United States, but none, to date, in the Gulf of Mexico region. H_2S concentrations in OCS vary from as low as a fraction ppm to as high as 650,000 ppm. The concentrations of H_2S found to date are generally greatest in the eastern portion of the CPA. The Occupational Safety and Health Administration's permissible exposure limit for H_2S is 10 ppm, which is 30 times lower than the "immediately dangerous to life and health" of 200 ppm set by the National Institute for Occupational Safety and Health. At about 500-700 ppm loss of consciousness and possible death can occur in 30-50 minutes. H_2S is a toxic gas; at lower concentrations, it is readily recognized by the “rotten egg” smell. Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage.

Summary and Conclusion

Accidents involving high concentrations of H_2S could result in deaths as well as environmental damage. Other emissions of pollutants into the atmosphere from accidental events as a result of a proposed action are not projected to have significant impacts on onshore air quality because of the prevailing atmospheric conditions, emissions height, emission rates, and the distance of these emissions from the coastline. These emissions are not expected to have concentrations that would change onshore air quality classifications. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} are estimated to be less than maximum increases allowed under the PSD Class I and II program.

4.4.3.5. Impacts on Marine Mammals

Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore are called blowouts. Blowouts can occur during any phase of development: exploratory drilling, development drilling, production, completion, or workover operations. In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill marine mammals, depending on their proximity to the accident. The effects of explosions and noise on marine mammals are discussed at length in Chapters 4.2.1.5 and 4.3.1.5.

Oil Spills

Each major grouping of marine mammals (e.g., manatees and dugongs, and baleen and toothed whales) confronts spilled hydrocarbons in different ways. Oil spills could affect marine mammals through various pathways: surface contact, inhalation, ingestion, and baleen fouling (Geraci, 1990). Much of the information on the effects of oil on marine mammals comes from studies of fur-bearing marine mammals (e.g., seals and sea lions, and sea otters). Sea otters exposed to the *Exxon Valdez* spill experienced high incidences of emphysema, petroleum hydrocarbon toxicosis, abortion, and stillbirths (Williams and Davis, 1995). Direct contact with oil and/or tar for cetaceans can lead to irritation and damage of skin and soft tissues (such as mucous membranes of the eyes), fouling of baleen plates so as to hinder the flow of water and interfere with feeding, and incidental ingestion of oil and/or tar. Studies by Geraci and St. Aubin (1982 and 1985) have shown that the cetacean epidermis functions as an effective barrier to noxious substances found in petroleum. Unlike other mammals, penetration of such substances in cetacean skin is impeded by tight intercellular bridges, the vitality of the superficial cells, the thickness of the epidermis, and the lack of sweat glands and hair follicles (Geraci and St. Aubin, 1985). The cetacean epidermis is nearly impenetrable, even to the highly volatile compounds in oil, and when skin is breached, exposure to these compounds does not impede the progress of healing (Geraci and St. Aubin, 1985). Cetacean skin is free from hair or fur, which in other marine mammals, such as pinnipeds and otters, tends to collect oil and/or tar, which subsequently reduces the insulating properties of the fur (Geraci, 1990). Dolphins maintained at a captive site in Sevastopol, Ukraine, that were exposed to petroleum products initially exhibited a sharp depression of food intake along with an excitement in behavior, eye inflammation, and changes in hemoglobin as well as erythrocyte content (Lukina et al., 1996). Prolonged exposure to oil led to a depression of those blood parameters, as well as changes in breathing patterns and gas metabolism, while nervous functions became depressed and skin injuries and burns appeared (Lukina et al., 1996). Experiments with harbor porpoise in similar conditions possibly resulted in aspiration pneumonia (Lukina et al., 1996). Dolphins exposed to oil at a Japanese aquarium that draws seawater from the ocean began developing cloudy eyes (Reuters, 1997).

Fresh crude oil or volatile distillates release toxic vapors that, when inhaled, can lead to irritation of respiratory membranes, lung congestion, and pneumonia. Subsequent absorption of volatile hydrocarbons into the bloodstream may accumulate into such tissues as the brain and liver, causing neurological disorders and liver damage (Geraci and St. Aubin, 1982; Hansen, 1985; Geraci, 1990).

Toxic vapor concentrations just above the water's surface (where cetaceans draw breath) may reach critical levels for the first few hours after a spill, prior to evaporation and dispersion of volatile aromatic hydrocarbons and other light fractions (Geraci and St. Aubin, 1982).

Trained, captive bottlenose dolphins exposed to oil could not detect light oil sheen but could detect thick dark oil based on visual, tactile, and presumably echolocation cues (Geraci et al., 1983; Smith et al., 1983). Studies of captive dolphins also showed that they completely avoided surfacing in slick oil after a few brief, initial tactile encounters. Reactions of free-ranging cetaceans to spilled oil appears varied, ranging from avoidance to apparent indifference (reviewed by Geraci, 1990; Smultea and Würsig, 1991). In contrast to captive dolphins, bottlenose dolphins during the *Mega Borg* spill did not consistently avoid entering slick oil, which could increase their vulnerability to potentially harmful exposure to oil chemicals (Smultea and Würsig, 1991 and 1995). It is possible that some overriding behavioral motivation (such as feeding) induced dolphins to swim through the oil; that slick areas were too large for dolphins to feasibly avoid, or that bottlenose dolphins have become accustomed to oil due to the extent of oil-related activity in the Gulf (Smultea and Würsig, 1995). The latter could result in temporary displacement from migratory routes. After the *Exxon Valdez* spill, killer whales did not appear to avoid oil; however, none were observed in heavier slicks of oil (Matkin et al., 1994). It is unknown whether animals in some cases are simply not affected by the presence of oil, or perhaps are even drawn to the area in search of prey organisms attracted to the oil's protective surface shadow (Geraci, 1990). The probable effects on cetaceans swimming through an area of oil would depend on a number of factors, including ease of escape from the vicinity, the health of the individual animal, and its immediate response to stress (Geraci and St. Aubin, 1985).

Spilled oil can lead to the localized reduction, extirpation, or contamination of prey species. Prey species, such as zooplankton, crustaceans, mollusks, and fishes, may become contaminated by direct contact and/or by ingesting oil droplets and tainted food. Marine fishes are known to take up petroleum hydrocarbons from both water and food, though apparently do not accumulate high concentrations of hydrocarbons in tissues, and may transfer them to predators (Neff, 1990). Cetaceans may consume oil-contaminated prey (Geraci, 1990) or incidentally ingest floating or submerged oil or tar. Hydrocarbons may also foul the feeding apparatus of baleen whales (though laboratory studies suggest that such fouling has only transient effects) (Geraci and St. Aubin, 1985). In general, the potential for ingesting oil-contaminated prey organisms with petroleum-hydrocarbon, body-burden content is highest for benthic feeding whales and pinnipeds. The potential is reduced for plankton-feeding whales and is lowest for fish-eating whales and pinnipeds (Würsig, 1990). Baleen whales occurring in the Gulf of Mexico feed on small pelagic fishes (such as herring, mackerel, and pilchard) and cephalopods (Cummings, 1985). An analysis of stomach contents from captured and stranded odontocetes suggest that they are deep-diving animals, feeding predominantly on mesopelagic fish and squid or deepwater benthic invertebrates (Heyning, 1989; Mead, 1989). Delphinids feed on fish and/or squid, depending upon the species (Mullin et al., 1991).

As noted by St. Aubin and Lounsbury (1990), there have been no experimental studies and only a handful of observations suggesting that oil has harmed any sirenian. Dugongs (relatives of the manatees) have been found dead on beaches after the Gulf War oil spill and the 1983 *Nowruz* oil spill caused by the Iran-Iraq War (Preen, 1991; Sadiq and McCain, 1993). Some dugongs were sighted in the oil sheen after the Gulf War (Pellew, 1991). Four types of impacts to dugongs from contact with oil include asphyxiation due to inhalation of hydrocarbons, acute poisoning due to contact with fresh oil, lowering of tolerance to other stress due to the incorporation of sublethal amounts of petroleum fractions into body tissues, and nutritional stress through damage to food sources (Preen, 1989, in Sadiq and McCain 1993). Manatees concentrate their activities in coastal waters, often resting at or just below the surface, which may bring them in contact with spilled oil (St. Aubin and Lounsbury, 1990). Manatees are nonselective, generalized feeders that might consume tarballs along with their normal food; such occurrences have been rarely reported (review in St. Aubin and Lounsbury, 1990). A manatee might also ingest fresh petroleum, which some researchers have suggested might interfere with the manatee's secretory activity of their unique gastric glands or harm intestinal flora vital to digestion (Geraci and St. Aubin, 1980; Reynolds, 1980). Oil spills within the confines of preferred river systems and canals, particularly during winter (when the animals are most vulnerable physiologically), could endanger local populations. Manatees able to escape such areas might be forced into colder waters, where thermal stress could complicate the effects of even brief exposure to oil (St. Aubin and Lounsbury, 1990). Such a scenario will expose them to increased vessel traffic, the primary cause of unnatural manatee deaths. This scenario is not one likely to be associated with offshore production or transportation of petroleum. The greater risk is from coastal accidents. For a population whose environment is already under great pressure, even a localized incident could be significant (St. Aubin and Lounsbury, 1990). Spilled oil might affect the quality or availability of aquatic vegetation, including seagrasses, upon which manatees feed.

Indirect consequences of oil pollution on marine mammals include those effects that may be associated with changes in the availability or suitability of prey resources (Hansen, 1992). Depending on the spatial scale and magnitude of an oil spill, diminished prey abundance and availability may cause marine mammal predators to move to less suitable areas and/or consume less suitable prey. In either case, the impact can be significant to a marine mammal population or stock. No long-term bioaccumulation of hydrocarbons have been demonstrated; however, an oil spill may physiologically stress an animal (Geraci and St. Aubin, 1980), making them more vulnerable to disease, parasitism, environmental contaminants, and/or predation.

Spill-Response Activities

Spill-response activities include the application of dispersant chemicals to the affected area (Chapter 4.4.2). Dispersant chemicals are designed to break oil on the water's surface into minute droplets, which then break down in seawater. Essentially nothing is known about the effects of oil dispersants on cetaceans, except that removing oil from the surface would reduce the risk of contact and render it less likely to adhere to skin, baleen plates, or other body surfaces (Neff, 1990). The acute toxicity of most oil dispersant chemicals is considered to be low relative to the constituents and fractions of crude oil and refined products, and studies have shown that the rate of biodegradation of dispersed oil is equal to or greater than that of undispersed oil (Wells, 1989). A variety of aquatic organisms readily accumulate and metabolize surfactants from oil dispersants. Enzymatic hydrolysis of the surfactant yields hydrophilic and hydrophobic components. The former probably are excreted via the gills and kidneys, whereas the latter accumulate in the gallbladders of fish and are excreted very slowly (Neff, 1990). Metabolism of surfactants is thought to be rapid enough that there is little likelihood of food chain transfer from marine invertebrates and fish to predators, including marine mammals (Neff, 1990).

Biodegradation is another process used for removing petroleum hydrocarbons from the marine environment, utilizing chemical fertilizers to augment the growth of naturally occurring hydrocarbon-degrading microorganisms. Toxic effects of these fertilizers on cetaceans are presently unknown.

Proposed Action Analysis

The potential causes, sizes, and probabilities of oil spills that could occur during drilling, production, and transportation operations associated with a proposed action are presented in Chapters 4.4.1 and 4.4.2. Table 4-47 lists estimates for spill magnitude and abundance for Gulf coastal waters as a result of a proposed action. Analogous estimates of spill magnitude and abundance for Federal OCS waters as a result of a proposed action are given in Table 4-44. However, estimates of where these accidents occur relative to water depth are not presented. Qualitative inspection of spill data indicates that the following will likely be in each planning area: many, frequent, small spills; few, infrequent, moderate-sized spills; and a single, unlikely, large spill. Such spills are attributed to the proposed actions. The assessment of spill frequency (i.e., frequent, infrequent, unlikely) is based relative to the 40-year life span of a proposed action.

Oil spills introduced specifically into coastal waters (as opposed to spills immigrating to coastal waters from offshore) as a result of a proposed action are assumed to encroach upon adjacent coastal lands. Spill estimates (Table 4-47) indicate that spills of $\leq$1 bbl will introduce 20-40 bbl of oil into coastal waters of the WPA over the 40-year life span. Spills of between >1 and <1,000 bbl of oil are expected to introduce about 200 bbl of oil in coastal waters of the WPA. A single spill of $\geq$1,000 bbl of oil may occur in coastal waters of the WPA. The total volume of spilled oil introduced into coastal waters of the WPA ranges from 200 to 3,200 bbl.

Spill estimates indicate that between 40 and 95 spills of $\leq$1 bbl of oil will be introduced into coastal waters of the CPA over a 40-year period. A total of 200-3,500 bbl of spilled oil is estimated for coastal waters of the CPA. Analysis of spill data also indicate that approximately 64 percent of coastal spills will occur in inland waters, 32 percent of coastal spills will occur in State offshore waters 0-3 mi from the coast, and 4 percent of coastal spills will occur in State offshore waters 3-12 mi from the coast (applicable to Texas).

The OSRA modeling results indicate that a large spill (≥1,000 bbl) occurring in Federal offshore waters stands a 5-8 percent probability of impacting Texas State waters, based on a proposed action for the WPA (Figure 4-16). Should a large oil spill occur as a result of a proposed action in the CPA, Texas coastal waters run a 1 percent risk of impact (Figure 4-16). Coastal waters of western and central Louisiana stand a 9-19 percent and 1-2 percent risk of impact from an OCS spill occurrence resulting from the proposed actions in the CPA and WPA, respectively. There is a 2-4 percent spill risk to Louisiana coastal waters east of the mouth of the Mississippi River (CPA proposed action only). The OSRA model projected no large spills reaching coastal waters eastward of Louisiana as a result of either proposed action (Figures 4-16 and 4-17).

In general terms, coastal waters of the CPA and WPA are expected to be impacted by many, frequent, small spills; few, infrequent, moderately-sized spills; and a single, large (≥1,000 bbl) spill. Pipelines pose the greatest risk of a large spill occurring in coastal waters. Matagorda County, Texas, and Plaquemines Parish, Louisiana, are the most likely landfall locations in the two planning areas, where such a large spill might occur.

Spills originating in or migrating through coastal waters may impact groups of the bottlenose dolphin, Atlantic spotted dolphin, or the West Indian manatee. Bottlenose dolphins are abundant in coastal waters of the Western Gulf. Manatees are rarely encountered in the Western Gulf north of Mexico.

Estimates from spill data show that Federal offshore waters will be subjected to many frequent small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 bbl and <1,000 bbl); and/or rare large spills (≥1,000 bbl) (Table 4-44) as a result of OCS activities. Spill estimates for the WPA indicate that 300-600 bbl of oil will be introduced in offshore waters from small spills (≤1 bbl). An additional 200-1,000 bbl of oil will be spilled in >1 to <1,000 bbl spill events. A single, large spill (≥1,000 bbl) is estimated to introduce approximately 4,600 bbl of oil. A single, but unlikely spill may occur that introduces as much as 15,000 bbl of oil. The total volume of oil spilled in Federal offshore waters as a result of a proposed action in the WPA is estimated at 500-22,000 bbl of oil spread over the 40-year life span of the proposed actions.

Oil-spill data derived from historical trends estimate that a total volume of 1,000-23,000 bbl of oil will be introduced into Federal offshore waters over 40 years as a result of the a proposed lease sale in the CPA. Small spills (≤1 bbl) are projected to introduce 700-1,500 bbl of oil. Moderate-sized spills (>1 to <1,000 bbl), though occurring less frequently than smaller spills, will introduce an estimated 300-1,400 bbl of oil. A large spill (≥1,000 bbl) is assumed to introduce approximately 4,600 bbl of oil as a result of a proposed action in the CPA. There is a 34-63 percent chance that a single spill exceeding 1,000 bbl will occur. In the rare event that a spill exceeding 10,000 bbl should occur, it is estimated that approximately 15,000 bbl of oil will be spilled. Additionally, there are 2-4 blowouts projected to occur as a result of a proposed lease sale in the CPA (Table 4-2).

In neritic waters (<200 m), platforms pose the most likely source of small spills, whereas pipelines pose the most likely source of a large spill. The most likely sources of spills in oceanic and outer shelf waters are subsea blowouts or pipeline ruptures.

The greatest diversity and abundance of cetaceans inhabiting the Gulf of Mexico is found in its oceanic and OCS waters. Individual cetaceans are not necessarily randomly distributed in the offshore environment, but are instead prone to forming groups of varying sizes. In some cases, several species may be found aggregating in the same area. Large spills, particularly those continuing to flow fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (days, weeks, months), pose an increased likelihood of impacting cetacean populations inhabiting these waters. Based on abundance estimates and a hypothetical spill surface area, spills occurring in these waters could impact more species and more individuals than coastal spills potentially impacting coastal marine mammals. It is noteworthy that the endangered sperm whales use oceanic waters as their principle habitat, and the northern Gulf is known to support approximately 300-500 of these animals.

There is an extremely small probability that a single cetacean will encounter an oil slick resulting from a single, small spill. Increasing the size of a slick or factoring in the number of estimated spills over 40 years, increases the likelihood that an animal will encounter a single slick during the lifetime of an animal; many cetacean species are long-live and may traverse throughout waters of the northern Gulf. The likelihood that a cetacean population may encounter an oil slick resulting from a single spill during a

40-year period is greater than that of a single individual encountering a slick during its lifetime. It is impossible to predict precisely which cetacean species, population or stock members, or individuals will be impacted, to what magnitude, or in what numbers, since each species has unique distribution patterns in the Gulf and because of difficulties attributed to predicting when and where oil spills will occur over a 40-year period.

Given the distribution of available leases and pipelines associated with the proposed actions and the distribution of marine mammals in the northern Gulf of Mexico, the fate of an oil spill must be considered relative to the region and period of exposure. Spill estimates derived from data documenting historical trends of oil spills in coastal and offshore waters indicate that the proposed actions in the WPA and CPA may introduce 2,000-50,000 bbl of oil into Gulf marine and estuarine environments over 40 years. Spills of any size degrade water quality, and residuals become available for bioaccumulation within the food chain. Slicks may spread at the sea surface or may migrate underwater from the seafloor through the water column and never broach the sea surface. Regardless, a slick is an expanding, but aggregated mass of oil that, with time, will disperse into smaller units as it evaporates (if at the sea surface) and weathers. Chapter 4.4.1.1.5.4 details the persistence, spreading, and weathering process for offshore spills. As the slick breaks up into smaller units (e.g., slickets) and soluble components dissolve into the seawater, tarballs may remain within the water column. Tarballs may subsequently settle to the seafloor or attach to other particles or bodies in the sea. As residues of an oil spill disperse and commit to the physical environment (water, sediments, and particulates), populations or stocks of oceanic cetaceans may be exposed via the waters that they drink and swim, as well as via the prey they consume. For example, tarballs may be consumed by marine mammals and by other marine organisms, and eventually bioaccumulate within marine mammalian predators. Although marine mammals may (or may not) avoid oil spills or slicks, it is highly unlikely that they are capable of avoiding spill residuals in their environment. Consequently, the probability that a marine mammal is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled as a result of the proposed actions during their lifetimes.

In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill marine mammals, depending on their proximity to the accident. There are 1-2 blowouts projected to occur as a result of a proposed action in the WPA (Table 4-3). There are 2-4 blowouts projected to occur as a result of a proposed action in the CPA (Table 4-2).

Blowouts, oil spills, and spill-response activities have the potential to adversely affect cetaceans, causing physical injury and irritation, fouling of baleen plates, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats or migration routes. If these accidental events occur within marine mammal habitat, some potential effects follow, given that animals are exposed to pollutants. Some short-term (0-1 month) effects of oil on cetacean assemblages may be (1) changes in species or social group distributions associated with avoidance of aromatic hydrocarbons and surface oil, changes in prey distribution, and human disturbance; (2) increased mortality rates from ingestion or inhalation of oil; (3) increased petroleum compounds in tissues; and (4) impaired health (e.g., immunosuppression) (Harvey and Dahlheim, 1994). Several mechanisms for long-term injury can be postulated: (1) initial sublethal exposure to oil causing pathological damage; (2) continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey; and (3) altered availability of prey as a result of the spill (Ballachey et al., 1994). While no conclusive evidence of an impact on cetaceans by the *Exxon Valdez* spill was uncovered (Dahlheim and Matkin, 1994; Harvey and Dahlheim, 1994; Loughlin, 1994), investigations on the effects on sea otters and harbor seals revealed pathological effects on the liver, kidney, brain (also evidenced by abnormal behavior), and lungs, as well as gastric erosions (Ballachey et al., 1994; Lipscomb et al., 1994; Lowry et al., 1994; Spraker et al., 1994). In addition, harbor seal pup production and survival appeared to be affected (Frost et al., 1994). A delayed effect of oil spills on river otters was strongly suggested in Bowyer et al. (1994). Studies of sea otters in western Prince William Sound in 1996-1998 indicate continued exposure to residual *Exxon Valdez* oil (Ballachey et al., 1999; Monson et al., 2000). Oil spills have the potential to cause greater chronic (longer-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on mammals than originally thought. A few long-term effects include (1) decreases in prey availability and abundance because of increased mortality rates; (2) change in age structure because certain year-classes were impacted more by oil; (3) decreased reproductive rate; and (4) increased rate of disease or neurological problems from exposure to oil (Harvey and Dahlheim, 1994). It has been speculated that new mortalities of killer whales may be linked to the *Exxon Valdez* spill (Matkin and Sheel, 1996). There was no evidence to directly link the Gulf War oil spill to marine mammal deaths that occurred during that time (Preen, 1991; Robineau and Fiquet, 1994). Effects of cleanup activities are unknown, but increased human presence (e.g., vessels) could add to changes in cetacean behavior and/or distribution, thereby additionally stressing animals, and perhaps making them more vulnerable to various physiologic and toxic effects.

Evidence gathered from the studies of the *Exxon Valdez* spill indicates that oil spills have the potential to cause chronic (sublethal oil-related injuries) and acute (spill-related deaths) effects on marine mammals. The effects were particularly pronounced on fur-bearing mammals (pinnipeds and sea otters) and less clear for cetaceans. Also, cetaceans do not always avoid contact with oil (e.g., Smultea and Würsig, 1995). Although an interaction with a spill could occur, primarily sublethal effects are expected due to avoidance and natural dispersion/weathering of the spill in the offshore environment.

Summary and Conclusion

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact marine mammals in the Gulf of Mexico. Characteristics of impacts (i.e., acute vs. chronic impacts) depend on the magnitude, frequency, location, and date of accidents, characteristics of spilled oil, spill-response capabilities and timing, and various meteorological and hydrological factors. Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to marine mammals occurring in the northern Gulf. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick will result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to marine mammals.

4.4.3.6. Impacts on Sea Turtles

Blowouts

Improperly balanced well pressures that result in sudden, uncontrolled releases of fluids from a wellhead or wellbore are called blowouts. Blowouts can occur during any phase of development: exploratory drilling, development drilling, production, completion, or workover operations. In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill sea turtles, depending on their proximity to the accident. The effects of explosions and noise on sea turtles is discussed at length in Chapters 4.2.1.5 and 4.3.1.5.

Oil Spills

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location; hydrocarbon type, dosage, and weathering; impact area; oceanographic and meteorological conditions; season; and life history stages of animals exposed to the hydrocarbons (NRC, 1985). All sea turtle species and life stages are vulnerable to the harmful effects of oil through direct contact or by fouling of their habitats and prey. Van Vleet and Pauly (1987) suggested that discharges of crude oil from tankers were having a significant effect on sea turtles in the Eastern Gulf of Mexico. Experiments on the physiologic and clinicopathologic effects of hydrocarbons have shown that major body systems of sea turtles are adversely affected by short exposure to weathered oil. Sea turtles accidentally exposed to oil or tarballs may suffer inflammatory dermatitis, ventilatory disturbance, salt gland dysfunction or failure, red blood cell disturbances, immune responses, and digestive disorders or blockages (Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Although disturbances may be temporary, long-term effects remain unknown, and chronically ingested oil may accumulate in organs. Direct contact with oil may harm developing turtle embryos. Exposure to hydrocarbons may be fatal, particularly to juvenile and hatchling sea turtles.

Oil can adhere to the body surface of marine turtles. Oil has been observed to cling to the nares, eyes, and upper esophagus, and to even seal the mouth (Witham, 1978; Overton et al., 1983; Van Vleet and Pauly, 1987; Gramentz, 1988; Lutcavage et al., 1995). Turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988; Gramentz, 1988). Periocular tissues and other mucous membranes would presumably be most sensitive to contact with hydrocarbons. Skin damage in turtles is in marked contrast to that observed in dolphins, where all structural and biochemical changes in the epidermis were minor and reversible. Changes in the skin are consistent with an acute, primary contact or irritant dermatitis. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection, neoplastic conditions, and debilitation (Vargo et al., 1986).

Turtles surfacing in an oil spill will inhale oil vapors. Any interference with operation of the lungs would probably reduce a sea turtle's capacity for sustained activity (aerobic scope) and its dive time, both effects decreasing the turtle's chance of survival.

Lutcavage et al. (1995) found that operation of the salt gland in sea turtles was disrupted with exposure to hydrocarbons, but the disturbance did not appear until several days after exposure. The salt glands did recover function when tested after two weeks of recovery. Prolonged interference with salt gland functioning could have serious consequences since it would interfere with both water balance and ion regulation.

Studies on the effect of oil on digestive efficiency are underway, but Lutcavage et al. (1995) report finding oil in the feces of turtles that swallowed oil in experiments. Van Vleet and Pauly (1987) reported that oil ingested by turtles did not pass rapidly through the digestive tract but was retained within the system for a period of several days, thus increasing the likelihood that toxic components of oil could be assimilated by other internal organs and tissues of the turtle.

Significant changes in blood chemistry following contact with hydrocarbons have been reported (Lutcavage et al., 1995). Hematocrit and hemoglobin concentration decreased slightly during contact; these parameters are critical components of the blood's oxygen transport system. The most striking hematologic finding was an elevation of white blood cell count, which may indicate a "stress" reaction related to oil exposure and/or toxicity.

Eggs, hatchlings, and small juveniles are particularly vulnerable if contacted (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Female sea turtles crawling through tar to lay eggs can transfer the tar to the nest; this was noted on St. Vincent NWR in 1994 (USDOI, FWS and USDOC NMFS, 1997). Potential toxic impacts to embryos will depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Embryonic development in an egg may be altered or arrested by contact with oil (Fritts and McGehee, 1982). Fresh oil was found to be highly toxic, especially during the last quarter of the incubation period, whereas aged oil produced no detectable effects. Fritts and McGehee (1982) concluded that oil contamination of nesting beaches would have its greatest impact on nests that were already constructed; nests made on fouled beaches are less likely to be affected, if at all. However, residual oil and tarballs may be integrated into nests by nesting females. Residues may agglutinate sand grains where eggs are deposited, later impeding hatchlings from successfully evacuating nests and ultimately leading to their death. Hatchling and small juvenile turtles are particularly vulnerable to contacting or ingesting hydrocarbons because the currents that concentrate oil spills also form the debris mats in which young turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990; Witherington, 1994). This would also be true for juvenile sea turtles that are sometimes found in floating mats of sargassum. Oil slicks, slicketts, or tarballs moving through offshore waters may foul sargassum mats that hatchling and juvenile sea turtles inhabit, which would conceivably result in the loss of sea turtle habitat or the "take" of sea turtles. The result of adult sea turtles feeding selectively in surface convergence lines could be prolonged contact with viscous weathered oil (Witham, 1978; Hall et al., 1983). High rates of oil contact in very young turtles suggest that bioaccumulation may occur over their potentially long lifespan. Exposure to hydrocarbons may begin as early as eggs are deposited in contaminated beach sand. A female coming ashore to nest might be fouled with oil or transport existing residues at the driftline to the nest. During nesting, she might push oil mixed with sand into the nest and contaminate the eggs (Chan and Liew, 1988). Assuming olfaction is critical to the process, oil fouling of a nesting area might disturb imprinting of hatchling turtles or confuse the turtles on their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985; Chan and Liew, 1988).

Some captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding the oil, or became agitated and had short submergence levels (Lutcavage et al., 1995). Sea turtles pursue and swallow tarballs, and there is no firm evidence that free-ranging turtles can detect and avoid oil (Odell and MacMurray, 1986). A loggerhead turtle sighted during an aerial survey in the Gulf of Mexico surfaced repeatedly within a surface oil slick for over an hour (Lohoefener et al., 1989). Oil might have a more indirect effect on the behavior of marine turtles. The effect on reproductive success could therefore be significant.

Contact with hydrocarbons may not cause direct or immediate death but cumulative sublethal effects, such as salt gland disruption or liver impairment, could impair the marine turtle's ability to function effectively in the marine environment (Vargo et al., 1986; Lutz and Lutcavage, 1989). Although many observed physiological insults are resolved in a 21-day recovery period, the impact of tissue oil intake on the long-term health and survival of sea turtles remains unknown (Lutcavage et al., 1995). There is evidence of bioacummulation in sea turtles exposed for longer periods of time. After the Gulf of Iraq war, a stranded green turtle did not appear to have contacted hydrocarbons, but upon necropsy, was found to have large amounts of oil in its liver and stomach tissues (Greenpeace, 1992).

A study of turtles collected during the *Ixtoc* spill determined that the three animals found dead had oil hydrocarbons in all tissues examined and that there was selective elimination of portions of this oil, indicating that exposure to the oil was chronic. The turtles evidently did not encounter the oil shortly before death but had been exposed to it for some time (Hall et al., 1983). The low metabolic rate of turtles may cause a limited capacity to metabolize hydrocarbons. Prolonged exposure to oil may have caused the poor body condition observed in the turtles, perhaps disrupting feeding activity. In such weakened condition, the turtles may have succumbed to some toxic component in the oil or some undiscovered agent.

The primary feeding grounds for adult Kemp's ridley turtles in the northern and southern Gulf of Mexico are near major areas of coastal and offshore oil exploration and production (USDOC, NMFS, 1992a). The nesting beach at Rancho Nuevo, Mexico, is also vulnerable and was indeed affected by the *Ixtoc* spill. The spill reached the nesting beach after the nesting season when adults had returned or were returning to their feeding grounds. It is unknown how adult turtles using the Bay of Campeche fared. It is possible that a high hatchling mortality occurred that year in the oceanic waters of the Gulf as a result of the floating oil.

Spill-Response Activities

In addition to the impacts from contact with hydrocarbons, spill-response activities could adversely affect sea turtle habitat and cause displacement from suitable habitat to inadequate areas. Impacting factors might include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some of the resulting impacts from cleanup could include interrupted or deterred nesting behavior, crushed nests, entanglement in booms, and increased mortality of hatchlings due to predation during the increased time required to reach the water (Newell, 1995; Lutcavage et al., 1997). The damage assessment and restoration plan/environmental assessment for the August 1993 Tampa Bay oil spill also noted that hatchlings that were restrained during the spill response were released on beaches other than their natal beaches, thus potentially losing them from the local nesting population (FDEP et al., 1997). Additionally, turtle hatchlings and adults may become disoriented and normal behavior disrupted by human presence as well as industrial activity. Individual turtles covered with oil have been cleaned, rehabilitated, and released (e.g., FDEP et al., 1997). The strategy for cleanup operations should vary, depending on the season, recognizing that disturbance to the nest may be more detrimental than the oil (Fritts and McGehee, 1982). As mandated by OPA 90, seagrass beds and live-bottom communities are expected to receive individual consideration during spill cleanup. Required spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil. Loggerhead turtle nesting areas in the Chandeleur Islands, Cape Breton National Seashore, and central Gulf States would also be expected to receive special cleanup considerations under these regulations. Studies are completely lacking regarding the effects of dispersants and coagulants on sea turtles (Tucker and Associates, Inc., 1990).

Proposed Action Analysis

Since sea turtle habitat in the Gulf includes inshore, neritic, and oceanic waters, as well as numerous beaches in the region, sea turtles could be impacted by accidental spills resulting from operations associated with the proposed actions in the CPA and WPA. The potential causes, sizes, and probabilities of oil spills that could occur during drilling, production, and transportation operations associated with a proposed action are presented in Chapters 4.4.1 and 4.4.2. Table 4-47 lists the estimates for spill magnitude and abundance for Gulf coastal waters as a result of a proposed action. Analogous estimates of spill magnitude and abundance for Federal OCS waters as a result of a proposed action are given in Table 4-44. However, estimates of where these accidents occur relative to water depth are not presented. Qualitative inspection of spill data indicates that the following will likely be in each planning area: many, frequent, small spills; few, infrequent, moderate-sized spills; and a single, unlikely, large spill. Such spills are attributed to a proposed action. The assessment of spill frequency (i.e., frequent, infrequent, unlikely) is based relative to the 40-year life span of a proposed action.

Oil spills introduced specifically into coastal waters (as opposed to spills immigrating to coastal waters from offshore) as a result of a proposed action are assumed to encroach upon adjacent coastal lands. Spill estimates (Table 4-47) indicate that spills ≤1 bbl will introduce 20-40 bbl of oil into coastal waters of the WPA over the 40-year life span. Spills of >1 and <1,000 bbl of oil are expected to introduce about 200 bbl of oil in coastal waters of the WPA. A single spill ≥1,000 bbl of oil may occur in coastal waters of the WPA. The total volume of spilled oil introduced into coastal waters of the WPA ranges from 200 to 3,200 bbl.

Spill estimates indicate that between 40 and 95 spills of ≤1 bbl of oil will be introduced into coastal waters of the CPA (Table 4-47) over a 40-year period. An additional 300-1,400 bbl of oil are estimated to be spilled into coastal waters of the CPA from spills of >1 to <1,000 bbl. A total of 200-3,500 bbl of spilled oil is estimated for coastal waters of the CPA. Analysis of spill data also indicate that approximately 64 percent of coastal spills will occur in inland waters, 32 percent of coastal spills will occur in State offshore waters 0-3 mi from the coast, and 4 percent of coastal spills will occur in State offshore waters 3-12 mi from the coast (applicable to Texas).

The OSRA modeling results indicate that a large spill (≥1,000 bbl) occurring in Federal offshore waters stands a 5-8 percent probability of impacting Texas State waters, based on a proposed action for the WPA (Figure 4-19). Should a large oil spill occur as a result of a proposed action in the CPA, Texas coastal waters run a 1 percent risk of impact (Figure 4-19). Coastal waters of western and central Louisiana stand a 9-18 percent and 1-2 percent risk of impact from an OCS spill occurrence resulting from proposed actions in the CPA and WPA, respectively. There is a 2-4 percent spill risk to Louisiana coastal waters east of the mouth of the Mississippi River (CPA proposed action only). The OSRA model projected no large spills reaching coastal waters eastward of Louisiana as a result of either proposed actions (Figure 4-19).

In general terms, coastal waters of the planning areas are expected to be impacted by many, frequent, small spills (≤1 bbl); few, infrequent, moderately-sized spills (>1 bbl and <1,000 bbl); and a single, large (≥1,000 bbl) spill. Pipelines pose the greatest risk of a large spill occurring in coastal waters. Matagorda County, Texas, and Plaquemines Parish, Louisiana, are the most likely landfall locations in the two planning areas, where such a large spill might occur.

Because oil spills introduced specifically in coastal waters of Texas and Louisiana are assumed to impact adjacent lands, there is a likelihood that spilled oil will impact nesting beaches in these states. Nesting beaches along south Texas, such as the Padre Island National Seashore, are susceptible to such spills, thereby potentially impacting the recovery of Kemp's ridley, hawksbill, green, and loggerhead sea turtle populations in the Western Gulf. In Louisiana, loggerhead nesting beaches on the Chandeleur Islands are vulnerable to an oil spill originating in adjacent waters; however, these islands do not appear to have been used in the last several years because they suffered significant hurricane damage.

Depending on the timing of the spill's occurrence in coastal waters, its impact and resulting cleanup may interrupt sea turtle migration, feeding, mating, and/or nesting activity for extended periods (days, weeks, months). Spills originating in or migrating through coastal waters of Texas or Louisiana may impact any of the five sea turtle species inhabiting the Gulf. Kemp's ridley is the most endangered sea turtle species and is strongly associated with coastal waters of Texas and Louisiana. Also, green, hawksbill, loggerhead, and leatherback sea turtles use coastal waters of the Western Gulf and whose densities may be considerably greater during warmer months than those occurring offshore during the same period. Aside from the acute effects noted if sea turtles encounter an oil slick, the displacement of sea turtles to less suitable habitats from habitual feeding areas impacted by oil spills may increase vulnerability to predators, disease, or anthropogenic mortality. A high incidence of juvenile sea turtle foraging occurs along certain coastal regions of the Gulf Coast. Prime examples of known foraging areas for juvenile sea turtles in the Gulf are the Texas Laguna Madre, extending from the Texas-Mexico border to Mansfield Pass, Texas, for green turtles; and Sea Rim State Park, Texas, to Mermentau Pass, Louisiana, for Kemp's ridleys (Renaud, 2001). The interruption of mating and nesting activities for extended periods may influence the recovery of sea turtle populations. For example, a large oil spill could inhibit the mating or nesting activity of the Kemp's ridley sea turtle at Texas beaches by limiting the number of eggs being fertilized or the number of nests being constructed for one or more years.

Estimates from spill data show that Federal offshore waters will be subjected to many frequent small spills ($\leq$1 bbl); few, infrequent, moderately-sized spills (>1 bbl and <1,000 bbl); and/or rare large spills (Table 4-44) as a result of the proposed actions. Spill estimates for the WPA indicate 300-600 bbl of oil will be introduced in offshore waters from small spills ($\leq$1 bbl). An additional 796-952 bbl of oil will be spilled in quantities of a >1 to <1,000 bbl spill event. A single, large spill ($\geq$1,000 bbl) is estimated to introduce approximately 4,600 bbl of oil. A single, but unlikely, spill may occur that introduces as much as 15,000 bbl of oil. The total volume of oil spilled in Federal offshore waters as a result of the four proposed actions in the WPA is estimated at 500-22,000 bbl of oil spread over the 40-year life span of the proposed actions.

Oil-spill data derived from historical trends estimate that a total volume of 1,000-23,000 bbl of oil will be introduced into Federal offshore waters over 40 years as a result of the proposed five lease sales in the CPA. Small spills ($\leq$1 bbl) are projected to introduce 300-600 bbl of oil. Moderate-sized spills (>1 and <1,000 bbl), though occurring less frequently than smaller spills, will introduce an estimated 300-1,400 bbl of oil. A large spill ($\geq$1,000 bbl) is assumed to introduce approximately 4,600 bbl of oil as a result of proposed actions in the CPA. There is a 34-63 percent chance that a single spill exceeding 1,000 bbl will occur. In the rare event that a spill exceeding 10,000 bbl should occur, it is estimated that approximately 15,000 bbl of oil will be spilled.

In neritic waters (<200 m), platforms pose the most likely source of small spills, whereas pipelines pose the most likely source of a large spill. The most likely sources of spills in oceanic and outer shelf waters are subsea blowouts or pipeline ruptures.

All neonate sea turtles undertake a passive voyage via oceanic waters following nest evacuation. Depending on the species and population, their voyage in oceanic waters may last 10 or more years. Beaches of the Caribbean Sea and Gulf of Mexico are used as nesting habitat, and hatchlings evacuating these nesting beaches emigrate to oceanic waters seaward of their nesting sites. Surface drifter card data (Lugo-Fernandez et al., 2001) indicate that circulation patterns in the Caribbean Sea and southern Gulf of Mexico may transport neonate and young juvenile sea turtles from these areas to oceanic waters off the coasts of Texas and Louisiana. Moreover, these journeys begin as pulsed events, with many hatchlings emerging and emigrating offshore at the same times. Oceanic OCS waters of the Gulf of Mexico are also inhabited by subadult and adult leatherback and loggerhead sea turtles; however, adults of any endemic sea turtle species may be found offshore. Consequently, intermediate to large spills occurring in these waters may impact multiple turtles, particularly neonate or young juvenile sea turtles associating with oceanic fronts or refuging in sargassum mats where oil slicks, decomposing residues, and tarballs are likely to accumulate. Large spills, particularly those flowing fresh hydrocarbons into oceanic and/or outer shelf waters for extended periods (days, weeks, months), pose an increased risk of impacting sea turtles inhabiting these waters. It is noteworthy that such an event may impact entire cohorts originating from nesting beaches in the Caribbean or southern Gulf, as well as those originating from Texas and Louisiana nesting beaches.

There is an extremely small probability that a single sea turtle will encounter an oil slick resulting from a single, small spill. Increasing the size of a slick or factoring in the number of estimated spills over 40 years increases the likelihood that an animal will encounter a single slick during the lifetime of an animal; many sea turtle species are long-live and may traverse throughout waters of the northern Gulf. The web of reasoning is incomplete without considering the abundance (stock or population) of each species inhabiting the Gulf. The likelihood that members of a sea turtle population (e.g., Kemp's ridley) may encounter an oil slick resulting from a single spill during a 40-year period is greater than that of a single individual encountering a slick during its lifetime. It is impossible to estimate precisely what sea turtle species, populations, or individuals will be impacted, to what magnitude, or in what numbers, since each species has unique distribution patterns in the Gulf and because of difficulties attributed to estimating when and where oil spills will occur over a 40-year period.

Given the distribution of available leases and pipelines associated with the proposed actions and the distribution of sea turtles in the northern Gulf of Mexico, the fate of an oil spill must be considered relative to the region and period of exposure. Spill estimates derived from data documenting historical trends of oil spills in coastal and offshore waters indicate that the proposed actions in the WPA and CPA may introduce 2,000-50,000 bbl of oil into Gulf offshore and coastal environments over 40 years. Spills of any size degrade water quality, and residuals become available for bioaccumulation within the food chain. Slicks may spread at the sea surface or may migrate underwater from the seafloor through the water column and never broach the sea surface. Regardless, a slick is an expanding, but aggregated mass of oil that, with time, will disperse into smaller units as it evaporates (if at the sea surface) and weathers. Chapter 4.4.1.1.5.4 details the persistence, spreading, and weathering process for offshore spills. As the slick breaks up into smaller units (e.g., slickets) and soluble components dissolve into the seawater, tarballs may remain within the water column. Tarballs may subsequently settle to the seafloor or attach to other particles or bodies in the sea. As residues of an oil spill disperse and commit to the physical environment (water, sediments, and particulates), sea turtles of any life history stage may be exposed via the waters that they drink and swim, as well as via the prey they consume. For example, tarballs may be consumed by sea turtles and by other marine organisms, and eventually bioaccumulate within sea turtles. Although sea turtles may (or may not) avoid oil spills or slicks, it is highly unlikely that they are capable of avoiding spill residuals in their environment. Consequently, the probability that a sea turtle is exposed to oil resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of sea turtles in the northern Gulf will be exposed to residuals of oils spilled as a result of the proposed actions during their lifetimes.

In general, on a yearly basis, about 1 percent of strandings identified by the U.S. Sea Turtle Stranding Network are associated with oil (e.g., Teas and Martinez, 1992). Turtles do not always avoid contact with oil (e.g., Lohoefener et al., 1989). Contact with petroleum and consumption of oil and oil-contaminated prey may seriously impact turtles; there is direct evidence that turtles have been seriously harmed by petroleum spills. Oil spills and residues have the potential to cause chronic (longer-term lethal or sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on turtles. Several mechanisms for long-term injury can be postulated: sublethal initial exposure to oil-causing pathological damage; continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey; and altered prey availability as a result of the spill.

Due to spill response and cleanup efforts, much of an oil spill may be recovered before it reaches the coast. However, cleanup efforts in offshore waters may result in additional harm or mortality of sea turtles, particularly to neonates and juveniles. Oil spills and spill-response activities at nesting beaches, such as beach sand removal and compaction, can negatively affect sea turtles. Although spill-response activities such as vehicular and vessel traffic during nesting season are assumed to affect sea turtle habitats, further harm may be limited because of efforts designed to prevent spilled oil from contacting these areas, as mandated by OPA 90. Increased human presence could influence turtle behavior and/or distribution, thereby stressing animals and making them more vulnerable to predators, the toxicological effects of oil, or other anthropogenic sources of mortality.

In the event of a blowout, the eruption of gases and fluids may generate significant pressure waves and noise that may harass, injure, or kill sea turtles, depending on their proximity to the accident. There are 1-2 blowouts projected to occur as a result of a proposed action in the WPA (Table 4-3). There are 2-4 blowouts projected to occur as a result of a proposed action in the CPA (Table 4-2).

Summary and Conclusion

Accidental blowouts, oil spills, and spill-response activities resulting from a proposed action have the potential to impact small to large numbers of sea turtles in the Gulf of Mexico, depending on the magnitude and frequency of accidents, the ability to respond to accidents, the location and date of accidents, and various meteorological and hydrological factors. Populations of sea turtles in the northern Gulf will be exposed to residuals of oils spilled as a result of a proposed action during their lifetimes. Chronic or acute exposure may result in the harassment, harm, or mortality to sea turtles occurring in the northern Gulf. In most foreseeable cases, exposure to hydrocarbons persisting in the sea following the dispersal of an oil slick will result in sublethal impacts (e.g., decreased health, reproductive fitness, and longevity; and increased vulnerability to disease) to sea turtles. Sea turtles hatchlings exposed to and becoming fouled by or consuming tarballs persisting in the sea following the dispersal of an oil slick would likely result in their death.

4.4.3.7. Impacts on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

Direct contact with spilled oil can cause skin and eye irritation to endangered beach mice. Other direct toxic effects include asphyxiation from inhalation of fumes, oil ingestion, and food contamination. Indirect impacts from oil spills would include reduction of food supply, destruction of habitat, and fouling of nests. Impacts can also occur from spill-response activities. Vehicular traffic and other activities associated with oil-spill cleanup can degrade preferred habitat and cause displacement of mice from these areas.

The ranges of the four endangered subspecies of beach mice are shown in Figure 4-20. For a proposed action in the CPA or WPA, the probabilities were low (<0.5%) that one or more offshore spills ≥1,000 bbl would occur and contact the shoreline inhabited by the Alabama, Choctawhatchee, St. Andrews, and Perdido Key beach mice during the life of a proposed action (2003-2042).

There is no definitive information on the persistence of oil, in the event a spill were to contact beach mouse habitat. In Prince William Sound, Alaska, after the *Exxon Valdez* spill in 1989, buried oil is being measured in the intertidal zone of beaches, but no effort has been made to search for residual buried oil above high tide. Similarly, NRC (1985) makes no mention of studies of oil left above high tide after a spill. Regardless of the potential persistence of oil in beach mouse habitat, a slick cannot wash above high tide, over the foredunes, and into the preferred habitat of the endangered beach mice unless the oil is carried by a heavy storm swell.

Summary and Conclusion

Given the low probability of a major (≥1,000 bbl) spill occurring and the necessity of coincident storm surge for oil to reach beach mouse habitat and contact the beach mice, no direct impacts of oil spills on beach mice from a proposed action are anticipated. Protective measures required under the Endangered Species Act should prevent any oil-spill response and clean-up activities from having significant impact to the beach mice and their habitat.

4.4.3.8. Impacts on Coastal and Marine Birds

Oil Spills

Oil spills pose the greatest potential impact to coastal and marine birds. Pneumonia is not uncommon in oiled birds and can occur when birds, attempting to clean their feathers through preening, inhale droplets of oil. Exposure to oil can cause severe and fatal kidney damage (reviewed by Frink, 1994). Ingestion of oils might reduce the function of the immune system and, thus, reduce resistance to infectious diseases (Leighton, 1990). Ingested oil may cause toxic destruction of red blood cells and varying degrees of anemia (Leighton, 1990). Stress and shock enhance the effects of exposure and poisoning. The pathological conditions noted in autopsies may be directly caused by petroleum hydrocarbons or may be a final effect in a chain of events with oil as the initial cause and generalized stress as an intermediate cause (Clark, 1984). Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration.

If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills, pipeline spills, and spills resulting from accidents in navigation waterways can contact and affect many of the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Some deaths from these groups are to be expected. Raptors, such as the bald eagle and peregrine falcon, feed upon weakened or dead birds (and fish, in the case of the eagle) and as a result may become physically oiled or affected by the ingestion of the oiled prey. Pelicans are active swimmers and plunge dive for prey. They are therefore susceptible to both physical oiling and secondary effects via ingestion of oiled prey (i.e., fish). Plovers congregate and feed along tidally exposed banks and shorelines, following the tide out and foraging at the water's edge. They have short stout bills and chase mobile prey rather than probing into the sediment with long slender bills like many birds of the sandpiper family. Plovers can physically oil themselves while foraging on oiled shores or secondarily contaminate themselves through ingestion of oiled intertidal sediments and prey. Oil will reach the intertidal beach feeding areas before it will contact nests on the fore dunes. The least tern captures fish by means of shallow splash diving and surface dipping techniques. Some physical oiling could occur during these dives, as well as secondary toxic effects through the uptake of prey. It is possible that some death of endangered/threatened (as well as nonendangered and nonthreatened) species could occur, especially if spills occur during winter months when raptors and plovers are most common along the coastal Gulf or if spills contact preferred or critical habitat. Recruitment through successful reproduction is expected to take several years, depending upon the species and existing conditions.

Direct oiling of wading birds, including some long-legged shorebirds, is usually minor because they will only be contaminated by a slick on the sea surface, which may contact the birds' legs, necks, bills, and heads, but little else, when they are feeding through the slick. Many of these birds are merely stained as a result of their foraging behaviors (Vermeer and Vermeer, 1975). Redwing blackbirds depend on stiff cattails to support their nests, so injury to such plants could result in reproductive failure. Birds can ingest oil when feeding on contaminated food items or drinking contaminated water. Oil contamination will affect prey upon which birds depend. Prey populations after the *Arthur Kill* spill (January 1990, south coast of New York) had not returned to normal a year after the spill.

Geese and herbivorous ducks feed at a lower trophic level than the other species of waterbirds and may not suffer damaging effects when oil is biomagnified, or at least not to the same degree (Maccarone and Brzorad, 1994). They still may encounter lower food availability, owing to the localized destruction of aquatic vegetation. Birds, such as ibises, that sift through mud and other sediments for small invertebrates may be exposed to high toxin levels in the invertebrates (Maccarone and Brzorad, 1994). Chapman (1981) noted that oil on the beach from the 1979 *Ixtoc* spill caused habitat shifts by the birds. Many birds had to feed in less productive feeding habitats. Similar observations were made for wading birds after the *Arthur Kill* spill (Maccarone and Brzorad, 1995). Composition of prey populations changed after the spill. Shoreline vegetation may die after prolonged exposure to water contaminated with oil. Lush vegetation helps to conceal sparsely placed nests and their contents from potential predators. With destruction of vegetation, aerial predators may have easier access to eggs and chicks (Maccarone and Brzorad, 1994). Many species have inherently low reproductive potential, slowing recovery from impacts.

A population that endures oil-spill impacts may have the disadvantage of a long-flying distance to habitat of neighboring colonies. Otherwise, neighboring colonies' habitat could provide refuge for a bird population fleeing impacts and be a source of recruitment to a population recovering from impacts (Cairns and Elliot, 1987; Trivelpiece et al., 1986; Samuels and Ladino, 1983/1984). In that case, population recovery following destruction of a local breeding colony or a large group of wintering migrants would likely occur within 1-2 yearly breeding cycles. For many coastal and marine species, spills may delay the maturation and reproduction process in juveniles, and this could cause a decrease in reproductive success for at least one season (Butler et al., 1988). Disruption of pair bonds and altered cycles of reproductive hormones might also affect reproductive success for one breeding season (Leighton, 1990).

Oil-Spill Response and Cleanup Activities

Oil-spill cleanup methods often require heavy trafficking of beaches and wetland areas, application of oil dispersants and bioremediation chemicals, and the distribution and collection of oil containment booms and absorbent material. The presence of humans, along with boats, aircraft, and other technological creations, will also disturb coastal birds after a spill. Investigations have shown that oil-dispersant mixtures pose a threat like that of oil to successful reproduction in birds (Albers, 1979; Albers and Gay, 1982). The external exposure of adult birds to oil/dispersant emulsions may reduce chick survival more than exposure to oil alone would; however, successful dispersal of a spill will generally reduce the probability of exposure of coastal and marine birds to oil (Butler et al., 1988). It is possible that changes in size of an established breeding population may also be a result of disturbance in the form of personnel for shoreline cleanup, monitoring efforts, or the intensified research activity after oil spills (Maccarone and Brzorad, 1994). Studies are indicating that rescue and cleaning of oiled birds makes no effective contribution to conservation, except conceivably for species with a small world population (Clark, 1978 and 1984). A growing number of studies indicate that current rehabilitation techniques are not effective in returning healthy birds to the wild (Anderson et al., 1996; Boersma, 1995; Sharp, 1995 and 1996). Preventative methods, such as scaring birds from the path of an approaching oil slick or the use of booms to protect sensitive colonies in an emergency, are also not effective (Clark, 1984).

Summary and Conclusion

Oil spills from a proposed action pose the greatest potential direct and indirect impacts to coastal and marine birds. Birds that are heavily oiled are usually killed. If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills, pipeline spills, and spills from accidents in navigated waterways can contact and affect the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Lightly oiled birds can sustain tissue and organ damage from oil ingested during feeding and grooming or from oil that is inhaled. Stress and shock enhance the effects of exposure and poisoning. Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration. Reproductive success can be affected by the toxins in oil. Indirect effects occur by fouling of nesting habitat, and displacement of individuals, breeding pairs, or populations to less favorable habitats.

Dispersants used in spill cleanup activity can have toxic effects similar to oil on the reproductive success of coastal and marine birds. The, air, vehicle, and foot traffic that takes place during shoreline clean up activity can disturb nesting populations and degrade or destroy habitat.

4.4.3.9. Impacts on the Gulf Sturgeon

Existing occurrences of Gulf sturgeon in 1996 extended from the Mississippi River to Charlotte Harbor in western Florida (Patrick, personal communication, 1996). Oil spills are the OCS-related factor most likely to impact the Gulf sturgeon. Oil can affect Gulf sturgeon by direct ingestion or ingestion of oiled prey or by the absorption of dissolved petroleum products through the gills. Upon any exposure to spilled oil, liver enzymes of adult fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Contact with or ingestion/absorption of spilled oil by adult Gulf sturgeon could result in mortality or sublethal physiological impact, especially irritation of gill epithelium and disturbance of liver function. Behavior studies of other fish species suggest that adult sturgeon are likely to actively avoid an oil spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982). Linden et al. (1979) note that early life stages of fish are very sensitive to the toxic effects of hydrocarbons. Fish eggs and larvae, with their limited physiology and mobility, are killed when contacted by oil (Longwell, 1977). As Gulf sturgeon deposit their eggs at the bottom of deep holes, the eggs and larvae are unlikely to come into contact with surface oil.

Chapter 4.4.1 discusses the risk of oil spills that could occur as a result of a proposed action in the CPA and WPA. Chapter 4.4.1.1.1.8 discusses the probability of occurrence and contact between a proposed-action-related spill and the coastal area known to be inhabited by the Gulf sturgeon. This analysis concluded that there is a very low risk of interaction between coastal waters inhabited by Gulf sturgeon and spills from proposed action accidents, few if any adult Gulf sturgeon are expected to be impacted by these spills.

Summary and Conclusion

The Gulf sturgeon could be impacted by oil spills resulting from a proposed action. Contact with spilled oil could cause irritation of gill epithelium and disturbance of liver function in Gulf sturgeon. The likelihood of spill occurrence and contact to the Gulf sturgeon as a result of a proposed action is very low.

4.4.3.10. Impacts on Fish Resources, Essential Fish Habitat, and Commercial Fisheries

Accidental events that could impact fish resources, essential fish habitat (EFH), and commercial fisheries include blowouts and oil or chemical spills. Due to the close association between discussions and proposed action analyses, the previously separate treatment of commercial fisheries has been combined in this single section. Impacts from other than accidental sources are discussed in Chapters 4.2.1.10 for the CPA and 4.3.1.8 for the WPA.

Blowouts

Subsurface blowouts have the potential to adversely affect fish resources and commercial fishing. A blowout at the seafloor could create a crater, and resuspend and disburse large quantities of bottom sediments within a 300-m radius from the blowout site, potentially affecting a limited number of fish in the immediate area. A blowout event, though highly unlikely, could cause damage to the nearby bottom and render the affected area closed to bottom fisheries, such as bottom longlining for tilefish or grouper, for some period of time. The majority of mobile fish taxa would be expected to leave the area (and not reenter) of a blowout before being impacted by the localized area of resuspended sediments. Blowouts may possibly result in the spillage of liquid hydrocarbons, but there have been no blowouts involving more than 500 bbl of spilled hydrocarbons since 1971 and they are not projected to occur during the period of a proposed action.

Resuspended sediments may clog gill epithelia of both finfish and shellfish with resultant smothering. Settlement of resuspended sediments may directly smother invertebrates or cover burrows of commercially important shellfish. However, sandy sediments are quickly redeposited within 400 m (1,312 ft) of the blowout site. Finer sediments are widely dispersed and redeposited over a period of hours to days within a few thousand meters depending on the particle size. Only gas-well blowouts are analyzed in this EIS. They are less of an environmental risk, resulting in resuspended sediments and increased levels of natural gas for a few days very near the source of the blowout. Loss of gas-well control does not release liquid hydrocarbons into the water. Natural gas consists mainly of methane, which rapidly disperses upward into the air (Van Buuren, 1984).

Spills

The risk of oil spills from a proposed action is discussed in Chapter 4.4.1.1; their characteristics, sizes, frequency, and fate are summarized in this chapter. Chapter 4.4.1.1.8 provides an analysis of the risk of fish being exposed to oil spills that could result from proposed action accidents. Spills that may occur as a result of a proposed action have the potential to affect fish resources, EFH, and commercial fishing in the Gulf. The toxicity of an oil spill depends on the concentration of the hydrocarbon components exposed to the organisms (in this case fish or "shellfish") and the variation of the sensitivity of the species considered. The geographic range of the pollutant effect depends on the mobility of the resource, the characteristics of the pollutant, and the tolerance of the resource to the pollutant in question. In this case, hydrocarbons are the primary pollutants of concern. The effects on and the extent of damage to fisheries resources and Gulf commercial fisheries from a petroleum spill are restricted by time and location. The impacts discussed in this EIS can be estimated from examinations of recent spills such as the *North Cape* (Rhode Island, 1996), *Breton Point* (Rhode Island, 1989), *Sea Empress* (United Kingdom, 1996), and *Exxon Valdez* (Alaska, 1989) (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). The amount of oil spilled by each event and its estimated impact to fishing practices, fish resources, and fisheries economics can be used as a guideline to estimate the impacts on fisheries.

The direct effects of spilled petroleum on fish occur through the ingestion of hydrocarbons or contaminated prey, through the uptake of dissolved petroleum products through the gills and epithelium by adults and juveniles, and through the death of eggs and decreased survival of larvae (NRC, 1985). Adult fish must experience continual exposure to relatively high levels of hydrocarbons over several months before secondary toxicological compounds that represent biological harm are detected in the liver (Payne et al., 1988). Upon exposure to spilled petroleum, liver enzymes of fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Ordinary environmental stresses may increase the sensitivity of fish to petroleum toxicity. These stresses may include changes in salinity, temperature, and food abundance (Evans and Rice, 1974; NRC, 1985).

When contacted by spilled hydrocarbon, floating eggs and larvae, with their limited mobility and physiology, and most juvenile fish are killed (Linden et al., 1979; Longwell, 1977). Large numbers of fish eggs and larvae have been killed by oil spills. Sublethal effects on larvae, including genotoxic damage have been documented from sites oiled from the *Exxon Valdez* (DeMarty et al., 1997). Hose and Brown (1998) also detected genetic damage in Pacific herring from sites within the oil trajectory of the *Exxon Valdez* spill two months after the spill with decreasing rates of genotoxicity for two additional months after the spill. No detectable genotoxicity was detectable from sampling conducted two years following the spill. Mortality rates for pink salmon embryos were found to be significantly higher than controls at exposure levels of 1 ppb total polycyclic aromatic hydrocarbons (PAH) concentration (Heintz, 1999). Fish over-produce eggs on an enormous scale and the overwhelming majority of them die at an early stage, generally as food for predators. Even a heavy death toll of eggs and larvae from an oil spill may have no detectable effect on the adult populations exploited by commercial fisheries. This has been confirmed during and after the *Torrey Canyon* spill off southwest England and the *Argo Merchant* spill off Nantucket. In both cases, a 90 percent death of fish eggs and larvae of pilchard and pollack, respectively, was observed in the affected area, but this had no impact on the regional commercial fishery (Baker et al., 1991).

Adult fish are likely to actively avoid a spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982; Maki et al., 1995). Observations at oil spills around the world, including the *Exxon Valdez* spill in Prince William Sound, consistently indicate that free-swimming fish are rarely at risk from oil spills (Lancaster et al., 1999; Squire, 1992). Fish swim away from spilled oil, and this behavior explains why there has never been a commercially important fish-kill on record following an oil spill. Modeling of impacts for the *North Cape* spill is an exception (French, 1998). The impact modeling for this heating oil spill off Rhode Island in 1996 included theoretical moralities of adult fish, but the model does not consider any avoidance of the spill area and mortality estimates were based on normal populations found in the area from previous trawling databases. (The *North Cape* spill was also unusual due to conditions that caused heavy entrainment of pollutants from large-wave turbulence, and hydrocarbons were retained in shallow water for many days due to tidal currents). Some recent work has demonstrated avoidance of extremely small concentrations of hydrocarbons. Farr et al. (1995) reported the behavioral avoidance of dissolved concentrations of a PAH as low as 14.7 μg/l by a species of minnow.

The only substantial adult fish-kill on record following an oil spill was on the French coast when several tons of small rock-clinging fish (not commercially harvested) were killed at the site of the *Amoco Cadiz* wreck. In addition, some concerns about the impact of spilled oil on the breeding cycle of commercial fishery resources have proved to be unfounded (Baker et al., 1991). Some recent work has reported potential sublethal impacts including the expression of subclinical viral infection correlated to experimental exposure of adult Pacific herring exposed to weathered crude oil (Carls et al., 1998).

Spills that contact coastal bays, estuaries, and waters of the OCS when pelagic eggs and larvae are present have the greatest potential to affect commercial fishery resources. For eggs and larvae contacted by a spill, the effect is expected to be lethal. Migratory species, such as mackerel, cobia, and crevalle, could be impacted if a spill contacts nearshore open waters. A spill contacting a low-energy inshore area would affect localized populations of commercial fishery resources, such as menhaden, shrimp, and blue crabs. The nearshore fishery was closed for approximately nine weeks in the case of the *North Cape* spill where dispersal of spilled oil away from shallow water was very slow. Chronic petroleum contamination in an inshore area would affect all life stages of a localized population of a sessile fishery resource such as oysters. Nonmotile shellfish (e.g., oysters) would not be able to avoid a spill but could shut down filtering for some period of time, depending on the water temperature and other environmental conditions.

For OCS-related spills to have an effect on an offshore commercial fishery resource, whether estuary dependent or not, eggs and larvae would have to be abnormally concentrated in the immediate spill area (Pearson et al., 1995). Hydrocarbon components also would have to be present in highly toxic concentrations when both eggs and larvae are in the pelagic stage (Longwell, 1977). Pearson et al. (1999) analyzed hypotheses of why the Pacific herring fisheries in Prince William Sound collapsed in 1993 and 1994, three years after the *Exxon Valdez* oil spill. A number of factors analyzed indicated that the 1989 oil spill did not contribute to the 1993 decline including the record high levels of harvests of Prince

William Sound herring in the years immediately following the oil spill, the lack of change from the expected age-class distribution, and the low level of oil exposure documented for the herring in 1989. Some reports indicate the impact of exposure of fish fry is limited. Birtwell et al. (1999) reported that exposure of populations of pink salmon fry to the aromatic hydrocarbon, water-soluble fraction of crude oil for 10 days and released to the Pacific Ocean did not result in a detectable effect on their survivability to maturity. There is no evidence at this time that commercial fisheries in the Gulf have been adversely affected on a regional population level by spills or chronic contamination.

Development abnormalities in juveniles occur naturally in wild fish populations, and the frequency of these abnormalities is increased in populations chronically exposed to petroleum. These abnormal fish do not survive long. Such delayed death is likely to have a negligible impact on commercial fisheries, as are the immediate deaths following a petroleum spill (Pearson et al., 1995).

If chemical spills occur, they will likely occur at the surface and most will rapidly dilute, affecting a small number of fish in a highly localized environment. Many of the chemical products that may be used offshore, such as methanol or hydrochloric acid, would chemically burn all exposed surfaces of fish that come in contact. The concentration of the chemical and the duration of exposure determines the extent of the chemical burn. Rapid dilution in seawater will limit the effects, and the impacts should be inconsequential. Other compounds such as zinc bromide will not readily dilute in seawater and will likely form slowly dissolving piles on the seafloor. Although these compounds may be toxic, mobile fishes will avoid them as they do oil spills. Nonmotile fish and slow-moving invertebrates could be killed. The areal extent of the impacts will be highly localized and the impacts should be inconsequential.

Proposed Action Analysis

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for species in the WPA and CPA region, EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). The effect of accidental events from a proposed action on coastal wetlands and coastal water quality is analyzed in Chapters 4.4.3.1.2 and 4.4.3.3.1, respectively.

Loss of well control and resultant blowouts seldom occur on the Gulf OCS. The potential causes and probabilities of blowouts are discussed in Chapter 4.4.1.2. A blowout with hydrocarbon release is not expected to occur. The few blowouts that could occur in the CPA or WPA as part of a proposed action would cause limited impacts to localized areas. Given the exposure of the area to high levels of suspended sediments in the CPA and WPA, and the low probability that a large blowout would occur, blowouts are not expected to significantly affect future water quality (EFH).

The potential causes, sizes, and probabilities of petroleum spills that could occur during activities associated with a proposed action are discussed in Chapter 4.4.1.1 and are listed in Table 4-44 for offshore spills and Table 4-47 for coastal spills. Information on spill response and cleanup is contained in Chapter 4.4.2.

There is a small risk of spills occurring during shore-based support activities (Chapter 4.4.1.1.7). Table 4-44 provides estimates of the number and size of spills projected to occur as a result of proposed CPA or WPA lease sale support activities in coastal waters. The great majority of these will be very small. Most of these incidents would occur at or near shore bases and are expected to affect a highly localized area with low-level impacts. Due to spill response and cleanup efforts, most of the inland spill would be recovered and what is not recovered would affect a very small area and dissipate rapidly.

The analysis of offshore spills occurring in the CPA or WPA combines both the percent chance (risk) a spill will occur with the probability the resulting spill will be transported by winds and currents to specific resources. Offshore spills <1,000 bbl estimated to occur as a result of a proposed action are not expected to reach a shoreline and impact important estuary EFH or other nearshore fishery habitat. Spills that contact coastal bays and estuaries in Texas or Louisiana would have the greatest potential to affect fish resources. The risk from a spill ≥1,000 bbl occurring and reaching shoreline areas of specific counties (or parishes) is presented in Figure 4-13. The risk and transport probability values for contact of a spill ≥1,000 bbl on Texas county or Louisiana parish shorelines with significant estuary resources are all small (including Matagorda, Brazoria, and Galveston Counties; and Lafourche, Jefferson, and Plaquemines Parishes), ranging from <0.5 to 8 percent.

The risk of a spill ≥1,000 bbl occurring, combined with transport probability for contact with the Flower Garden Banks, an EFH Habitat Area of Particular Concern (HAPC), ranges from <0.5 to 4 percent; however, the shallowest portion of the Flower Garden Banks is 18 m, and no measurable concentrations of hydrocarbon contaminants is expected to reach these depths (Chapter 4.4.1.1.8). The biological resources of other hard/live bottoms in the Gulf of Mexico (EFH) would remain unharmed as spilled substances could, at the most, reach the seafloor in minute concentrations (see also Chapter 4.4.3.2.1). These minute quantities may cause very short-term sublethal effects (changes in physiology) in benthic organisms that will recover quickly. It is also assumed that a petroleum spill will occasionally contact and affect nearshore and coastal areas of migratory Gulf fisheries. These species are highly migratory and will actively avoid the spill area.

The effect of petroleum spills on fish resources as a result of a proposed action is expected to cause less than a 1 percent decrease in fish resources or standing stocks of any population. At the expected level of impact, the resultant influence on fish populations within or in the general vicinity of the proposed CPA or WPA lease sale areas would be negligible and indistinguishable from natural population variations.

Commercial fishermen will actively avoid the area of a blowout or spill. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches will prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area. This, in turn, could decrease landings and/or the value of catch for several months. However, Gulf of Mexico species can be found in many adjacent locations. Gulf commercial fishermen do not fish in one locale and have responded to past petroleum spills, such as that in Lake Barre in Louisiana, without discernible loss of catch or income by moving elsewhere for a few months. In the case of a blowout, it is unlikely that commercial fishermen will actively avoid areas of increased turbidity since many areas that receive heavy fishing pressure in the Gulf are highly turbid.

Summary and Conclusion

Accidental events resulting from oil and gas development in CPA and WPA lease sale areas of the Gulf of Mexico have the potential to cause some detrimental effects on fisheries and fishing practices. It is expected that subsurface blowouts that may occur as a result of a proposed action would have a negligible effect on Gulf fish resources or commercial fishing. If spills due to a proposed action were to occur in open waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be sublethal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. The effect of proposed-action-related oil spills on fish resources and commercial fishing is expected to cause less than a 1 percent decrease in standing stocks of any population, commercial fishing efforts, landings, or value of those landings. Any affected commercial fishing activity will recover within 6 months. At the expected level of impact, the resultant influence on fish populations and commercial fishing activities within the CPA or WPA lease sale areas would be negligible and indistinguishable from variations due to natural causes.

It is expected that coastal environmental degradation from a proposed action would have little effect on fish resources or EFH; however, wetland loss could occur due to a petroleum spill contacting inland areas.

4.4.3.11. Impacts on Commercial Fisheries

This section was combined with the above section on fish resources and essential fish habitats.

4.4.3.12. Impacts on Recreational Beaches

Oil spills can be associated with the exploration, production, or transportation phases of OCS operations. Major oil spills contacting recreational beaches can cause short-term displacement of recreational activity from the areas directly affected, including the closure of beaches for periods of 2-6 weeks or until the cleanup operations are complete. A large oil spill resulting from the proposed actions would acutely threaten recreational beaches for up to 30 days. The risk of a spill occurring and contacting recreational beaches is described under Chapter 4.4.1.1.8. Natural processes such as weathering and dispersion and human efforts to contain and remove the spill would significantly change the nature and form of the oil. Factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, cleanup methods (if any), and publicity can have a bearing on the severity of effects on a recreational beach and its use.The primary impact-producing factors associated with offshore oil and gas exploration and development, and most widely recognized as major threats to the enjoyment and use of recreational beaches, are oil spills and offshore trash, debris, and tar. All of the respondents from a total of 39 semi-structured discussions conducted from March through May 1997 for the MMS study, "Socioeconomic and Environmental Issues Analysis of Oil and Gas Activity on the Outer Continental Shelf of the Western Gulf of Mexico," recognized environmental threats posed by the nature and specific operations of the industry (Kelley, in press). Most respondents to the study believed that a major oil spill would have devastating effects on the tourist industry. While "small" spills were deemed to occur with some frequency, it is "the big one" that people fear most. Offshore trash and tar is often noted as the second biggest threat to the conditions of the beaches in the Gulf of Mexico coastal region. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation. Soil contamination and air and water pollution created by the refining of oil and the production of petrochemical products are other areas of concern.

Section 4.4.1 discusses the risk of spill occurrence, the number of spills estimated for the OCS Program, and the likelihood of an OCS-spill contacting the Gulf Coast. The scenarios analyzed are hypothetical oil spills of 4,600 bbl and >10,000 bbl occurring from future OCS oil and gas operations in the Gulf of Mexico. Should such a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks or until the cleanup operations were complete. Should a spill occur, factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods would have a bearing on the severity of effects the spill would have on a recreational beach and its use. Sorenson (1990) reviewed the economic effects of several historic major oil spills on beaches and concluded that a spill near a coastal recreational area would reduce visitation in the area by 5-15 percent over one season but would have no long-term effect on tourism.

Tarballs (the floating residue remaining after an oil slick dissipates) are likely results from a large spill. Tarballs are known to persist as long as 1-2 years in the marine environment. An MMS-funded study investigated the abundance and sources of tarballs on the recreational beaches of the CPA (Henry et al., 1993). The study concluded that the presence of tarballs along the Louisiana coastline is primarily related to marine transportation activities and that their effect on recreational use is below the level of social and economic concern.

Summary and Conclusion

It is unlikely that a spill would be a major threat to recreational beaches because any impacts would be short-term and localized. Should a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks or until the cleanup operations were complete. Should a spill result in a large volume of oil contacting a beach or a large recreational area being contacted by an oil slick, visitation to the area could be reduced by as much as 5-15 percent for as long as one season, but such an event should have no long-term effect on tourism.

Tarballs can lessen the enjoyment of the recreational beaches but should have no long-term effect on the overall use of beaches.

4.4.3.13. Impacts on Archaeological Resources

Spills, collisions, and blowouts are accidental events that can happen in association with oil and gas operations. If an accidental event occurs as a result of one of these events, there could be an impact to archaeological resources. Oil spills have the potential to affect both prehistoric and historic archaeological resources. Impacts to historic resources would be limited to visual impacts and, possibly, physical impacts associated with spill cleanup operations. Impacts to prehistoric archaeological sites would be the result of hydrocarbon contamination of organic materials, which have the potential to date site occupation through radiocarbon dating techniques, as well as possible physical disturbance associated with spill cleanup operations.

4.4.3.13.1. Historic Archaeological Resources

The risk of contact to archaeological resources from oil spills associated with proposed action operations is described in Chapter 4.4.1.1. Should an oil spill contact a coastal historic site, such as a fort or a lighthouse, the major impact would be a visual impact from oil contact and contamination of the site and its environment. Impacts to coastal historic sites are expected to be temporary and reversible. Should such an oil spill contact an onshore historic site, the effects would be temporary and reversible.

Oil released subsea as a result of a blowout or pipeline incident would not be expected to contact an offshore sunken historic resource such as a shipwreck.

Summary and Conclusion

Impact to a historic archaeological resource could occur as a result of an accidental spill. As indicated in Chapter 4.4.1.1, it is not very likely that an oil spill will occur and contact coastal historic archaeological sites from accidental events associated with a proposed action in the WPA or CPA. The major effect from an oil-spill impact would be visual contamination of a historic coastal site, such as a historic fort or lighthouse. As historic archaeological sites are protected under law, it is expected that any spill cleanup operations would be conducted in such a way as to cause little or no impacts to historic archaeological resources. These impacts would be temporary and reversible.

4.4.3.13.2. Prehistoric Archaeological Resources

Prehistoric archaeological sites on barrier islands and along beaches may be damaged by oil spilled as the result of an accidental event. The risk of oil spills occurring and contacting coastal areas is described in Chapter 4.4.1.1. Direct physical contact of spilled oil with a prehistoric site could coat fragile artifacts or site features with oil. The potential for radiocarbon dating organic materials in the site also could be adversely affected. Ceramic or lithic seriation or other relative dating techniques might ameliorate this loss of information. It is also sometimes possible to decontaminate an oiled sample for radiocarbon dating. Recent investigations into archaeological damage associated with the *Exxon Valdez* oil spill in the Gulf of Alaska revealed that oil did not penetrate the subsoil or into wooden artifacts in the intertidal zone, apparently because of hydrostatic pressure (*Federal Archaeology*, 1994).

Coastal prehistoric sites could experience an impact from oil-spill cleanup operations, including possible site looting from oil spill cleanup crews. Cleanup equipment could destroy fragile artifacts and disturb the provenience of artifacts and site features. Some of the coastal prehistoric sites that might be impacted by beach cleanup operations may contain unique and significant scientific information. In Louisiana, Mississippi, and Alabama, prehistoric sites occur frequently along the barrier islands and mainland coast and along the margins of bays and bayous. Paleo-Indian artifacts have been recovered from barrier islands offshore Mississippi (McGahey, personal communication, 1996). Should an oil spill contact a coastal prehistoric site, there could be a loss of significant archaeological information on the prehistory of North America and the Gulf Coast region.

Summary and Conclusion

Accidental events producing oil spills may threaten the prehistoric archaeological resources of the Gulf Coast. Impacts to prehistoric sites could occur as a result of an oil spill. Should a spill contact an archaeological site, damage might include loss of radiocarbon-dating potential, direct impact from oil-spill cleanup equipment, and/or looting. Previously unrecorded sites could be impacted by oil-spill cleanup operations on beaches.

As indicated in Chapter 4.4.1.1, it is not very likely for an oil spill to occur and contact coastal and barrier island prehistoric sites as a result of a proposed action in the WPA or CPA. The proposed actions are not expected to result in impacts to prehistoric archaeological sites; however, should such an impact occur, unique or significant archaeological information could be lost and this impact would be irreversible.

4.4.3.14. Impacts on Human Resources and Land Use

4.4.3.14.1. Land Use and Coastal Infrastructure

Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on land use. Coastal or nearshore spills could have short-term adverse effects on coastal infrastructure requiring clean up of any oil or chemicals spilled.

4.4.3.14.2. Demographics

Accidental events such as oil or chemical spills, blowouts, and vessel collisions would have no effects on the demographic characteristics of the Gulf coastal communities.

4.4.3.14.3. Economic Factors

The resource costs of cleaning up an oil spill, either onshore or offshore, were not included in the economic analyses for a proposed action in the CPA (Chapter 4.2) and WPA (Chapter 4.3) for two reasons. First, the potential impact of oil-spill cleanup activities is a reflection of the spill's opportunity cost. The cleanup and remediation of an oil spill involves the expenditure of millions of dollars and the creation of hundreds of jobs. While such expenditures are revenues to business and employment/revenues to individuals, the cost of responding to a spill is not a benefit to society and is a deduction from any comprehensive measure of economic output. An oil spill's opportunity cost has two generic components: cost and lost opportunity. Cost is the value of goods and services that could have been produced with the resources used to cleanup and remediate the spill if the resources had been able to be used for production or consumption. The second is the value of the opportunities lost or precluded to produce (e.g., harvest oysters) or consume (e.g., recreational/tourism activities) (Pulsipher et al., 1999). The second reason for excluding the costs of cleaning up an oil-spill from the proposed action economic analyses is that the occurrence of a spill is not a certainty. Spills are random accidental events. Even if a proposed CPA or WPA lease sale was held, leases let, and oil and gas produced, the timing, numbers, sizes, offshore locations of occurrence, and onshore locations of contact of potential spills occurring over the life of a proposed action are all unknown variables. Additionally, the cost involved in any given cleanup effort is influenced by a variety of factors: whether or not the oil comes ashore; the type of coastal environment contacted by the spill; weather conditions at the time of the incident; the type and quantity of oil spilled; and the extent and duration of the oiling. Nevertheless, the same two-step model used in Chapters 4.2 and 4.3 to project employment for a proposed CPA or WPA lease sale was applied to project the opportunity cost employment associated with cleaning up an oil spill. In this case, the first step considered estimates of the expenditures resulting from oil-spill cleanup activities should a spill occur and contact land. Table 4-48 depicts the sectoral allocation of the spending associated with spill cleanup and remediation activities. The amount spent per industrial sector to clean up a spill varies depending on such factors as the water depth in which the spill occurs and whether or not the spill contacts land. In any case the legal sector receives the majority of oil-spill cleanup expenditures. The second step incorporated the IMPLAN regional model multipliers to translate those expenditures into direct, indirect, and induced employment associated with oil-spill cleanup activities.

Chapter 4.4.1.1 depicts the risks and number of spills estimated to occur for a proposed CPA or WPA lease sale. The average size (on which model results are based) estimated for a spill ≥1,000 bbl is 4,600 bbl. Based on model results, should such a spill occur and contact land, it is projected to cost 363 person-years of employment for cleanup and remediation. This represents less than 1 percent of baseline employment for the analysis area even if the spill was to occur during the peak year of employment for a CPA or WPA lease sale. The most probable area to be affected by a spill is Plaquemines Parish in the CPA and Matagorda County in the WPA. Table 4-49 summarizes the direct, indirect, and induced opportunity cost employment (by subarea and planning area) for an oil-spill cleanup should a spill occur and contact land.

Chapter 4.4.1.1 shows that over the life of a proposed CPA or WPA lease sale spills less than 1,000 bbl are likely to occur and the most likely size is less than 1 bbl. It is estimated that between 930 and 2,212 small (<1 bbl) spills may occur in the CPA and between 460 and 880 spills may occur in the WPA. A few spills ≥1 bbl and <500 bbl are also estimated to occur offshore. These spills are not expected to reach land, and cleanup employment associated with such small spills is projected to be negligible. Facilities are equipped and employees are trained for such occurrences.

Chapter 4.4.1.1 conveys there is a lesser chance that an offshore spill ≥10,000 bbl may occur over the life of the proposed actions. Even though the probability of such a spill is minimal, employment impacts were analyzed should such a spill occur. Tables 4-50 and 4-51 contains these estimates. Opportunity cost employment associated with the cleanup and remediation of a spill ≥10,000 bbl is estimated between 505 and 1,183 person-years of employment depending on the location of such a spill and whether or not oil contacts land. This employment is expected to be temporary and of short duration (less than one year aside from the legal industry involvement). Cleanup employment is not expected to exceed 1 percent of baseline employment for any subarea in any given year even if it is included with employment associated with oil and gas development activities associated with a CPA or WPA lease sale.

The immediate social and economic consequences for the region in which a spill occurs are a mix of things that include not only additional opportunity cost jobs and sales but also non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations. These negative short-term social and economic consequences of an oil spill are expected to be modest as measured by projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill (Pulsipher et al., 1999). Chapters 4.4.3.9 and 4.4.3.11 include additional discussions of the potential consequences of an oil spill on commercial fisheries and recreational beaches.

Overall employment projected for all OCS oil and gas activities includes employment in the oil-spill response industry. Overall OCS employment is projected to be substantial (up to 6% of baseline employment in some subareas).

Tarballs (the floating residue remaining after an oil slick dissipates) are likely results from a large spill. Tarballs are known to persist as long as 1-2 years in the marine environment. Findings from an MMS study investigating the abundance and sources of tarballs on the recreational beaches of the CPA concluded that the presence of tarballs along the Louisiana coastline is primarily related to marine transportation activities and that their effect on recreational use is below the level of social and economic concern (Henry et al., 1993).

Summary and Conclusion

The short-term social and economic consequences for the Gulf coastal region should a spill ≥1,000 bbl occur includes opportunity cost of 363-1,183 person-years of employment and expenditures of $20.7-$67.5 million that could have been gone to production or consumption rather than spill-cleanup efforts. Non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations are also expected to occur in the short-term. These negative, short-term social and economic consequences of an oil spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill.

4.4.3.14.4. Environmental Justice

Oil spills that enter coastal waters can have negative economic or health impacts on the many people who use those waters for fishing, diving, boating, and swimming. According to the MMS oil-spill analysis, there is a low chance that an accidental oil spill ≥1,000 bbl will occur and contact Gulf coastal waters as a result of a proposed action. That chance is <0.5-8 percent for Texas coastal waters, <0.5-18 percent for Louisiana coastal waters, and <0.5 percent for Mississippi, Alabama, and Florida coastal waters (Chapter 4.4.1.1).

Should an oil spill occur and contact coastal areas, any adverse effects would not be expected to disproportionately impact minority or low-income populations. The populations immediately adjacent to the coast are not physically, culturally, or economically homogenous. The homes and summer homes of the relatively affluent line much of the Gulf Coast, and this process of gentrification is ongoing. As shown by Figures 3-15 and 3-16 in Chapter 3.1.1.1, coastal concentrations of minority and low-income populations are few and mostly urban. The higher probabilities of oil contacting land in Louisiana are centered on South Pass and Southwest Pass at the confluence of the deltaic plain and the Gulf of Mexico (Chapter 4.4.1.1). In Louisiana, Grand Isle is the only inhabited barrier island, and this community is not predominantly minority or low income. Most of the Louisiana coast, including South Pass, Southwest Pass, and the shorelines of the census tracts around Morgan City and the lower Mississippi Delta identified as minority concentrations (Figure 3-15), are virtually uninhabited and uninhabitable.

The users of the coast and coastal waters are not physically, culturally, or economically homogenous. Recreational users of coastal waters tend to be relatively affluent. For example, a recent survey of recreational and party-boat fishing around offshore oil rigs found significant per capita costs (Hiett and Milon, in press). Offshore commercial fishing involves significant capital outlays that limit participation. One MMS-funded study of the Houma in Lafourche Parish found that they focus their commercial and subsistence activities on inland and nearshore wild resources, less capital demanding pursuits (Fischer, 1970).

The direct impacts of an oil spill are unlikely to disproportionately affect minority or low-income people. Oil spills can have indirect effects, such as through serious, short-term impacts on tourism; however, these too are unlikely to disproportionately affect minority or low-income people.

Summary and Conclusion

Considering the low likelihood of an oil spill and the nonhomogeneous population distribution along the Gulf of Mexico region, accidental spill events associated with a proposed action are not expected to have disproportionate adverse environmental or health effects on minority or low-income people.

4.5. CUMULATIVE IMPACTS

4.5.1. Coastal Barrier Beaches and Associated Dunes

This cumulative analysis considers the effects of impact-producing factors related to a proposed action, prior and future OCS sales in the Gulf of Mexico, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes that may affect barrier beaches and dunes. Specific impact-producing factors considered in this cumulative analysis include erosion and reduced sedimentation, beach protection and stabilization projects, oil spills, oil spill response and clean up activities, pipeline landfalls, navigation channels, and recreational activities.

Erosion of barrier islands in coastal Louisiana and easternmost Texas is related to the stages of construction and destruction of the Mississippi River Delta. The Mississippi River is the most influential direct and indirect source of sand-sized and other sediments to coastal landforms in Louisiana. The location of the river determines which areas of the deltaic plain accrete and erode. Typically, rivers and their distributaries build land where they flood the delta and discharge to the Gulf. Land erodes and subsides where sediments are no longer received from the river or other sources

Since the lower Mississippi River was completely leveed and channeled by the early 1930's, the vast majority of land-building sediments were channeled to the end of the Bird Foot Delta (coastal Subarea LA-3), from where they are largely distributed to deepwater areas of the continental slope. Levees and channelization ended the once-significant land building in Louisiana and set circumstances toward deltaic degradation and subsidence, as if the river had abandoned this area of the coast.

Within a decade after the Civil War, the State of Louisiana connected the Mississippi, Red, and Atchafalaya Rivers for navigational purposes, which began the diversion of the more sediment-laden waters of the Mississippi River to the Atchafalaya River. By 1932, the Federal Government diverted the Red River and increased Mississippi River flow to the Atchafalaya River for flood control. By 1962, the Federal Government constructed the Old River Control Structure, which diverts approximately 30 percent of the Mississippi River flow to the Atchafalaya River. This diversion also led to the development of a new deltaic lobe in the Atchafalaya Bay (coastal Subarea LA-2).

Since the 1950's, the suspended sediment load of the Mississippi River has decreased more than 50 percent, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation measures within the drainage basin. Sediment loads in the Atchafalaya River also decreased as a result.

Reduced sediment supply to the Louisiana coast has contributed to erosional forces becoming dominant. Erosional reworking of deltaic sediments winnows away the lighter sediments and retains the heavier, sand-sized materials that build barrier beaches. Unfortunately, very little of these coarser materials are present in the deltaic deposits of these regions. Consequently, these beaches are rapidly retreating landward and will continue to do so into the foreseeable future. Generally under these circumstances, installation of facilities on these beaches or dunes or removal of large volumes of sand from this littoral system can cause strong, adverse impacts. One of the least stable beach and dune systems is at Fourchon in Lafourche Parish, where tank farms and other businesses have been forced to move inland, away from the rapidly eroding beach.

The beaches and dunes of the Chandeleur Islands to the east of the Mississippi River Delta are not dependent on a fluvial source of sand. These islands are nourished by the sandy barrier platforms beneath them (Otvos, 1980). Reduced discharges of fluvial sediment into the coastal zone will not affect these barriers. Still, their sand supplies are limited and they have not recovered rapidly after hurricanes of the last decade.

Approximately 280 km of the Texas coast are experiencing erosion (Wicker et. al. 1989). The weighted average erosion rate along this stretch of coast is 5.9 m/yr. Another 212 km of coast are experiencing loss at an average rate of 2.9 m/yr. The average change over the entire Texas coast has been erosional at a rate of 2.1 m/yr. During this century, the annual rate of coastal landloss in Texas has increased from 13 ha at the turn of the century to nearly 65 ha in 1980 (Morton, 1982). These trends are caused by the following circumstances. The Texas coast has experienced a natural decrease in sediment supply as a result of climatic changes that have occurred during the past few thousand years (Morton, 1982). Dam construction upstream on coastal rivers has trapped sand-sized sediments. Shoreline stabilization using groins and jetties has trapped sediment on the updrift sides of the structures. Seawall construction along eroding stretches of islands has reduced the amount of sediment introduced into the littoral system by shore erosion. The Texas Chenier Plain receives reworked sediments that have been discharged by the Mississippi River, which have decreased by more than 50 percent since the 1950's. Reductions in sediment supply along the Texas coast will continue to have a significant adverse impact on barrier landforms there.

Subsidence, erosion, and dredging of inland coastal areas and the concurrent expansion of tidal influences, particularly as seen in Louisiana, continually increases tidal prisms around the Gulf. These changes will cause many new natural, tidal channels to be opened, deepened and widened not only to the Gulf but also between inland waterbodies to accommodate the increasing volumes of water that are moved by tides and storms. These changes will cause adverse impacts to barrier beaches and dunes that will be incremental in nature.

Efforts to stabilize the Gulf shoreline have adversely impacted barrier landscapes in Louisiana and Texas. Large numbers and varieties of stabilization techniques, such as groins, jetties, and seawalls, as well as artificially-maintained channels and jetties, installed to stabilize navigation channels have been applied along the Gulf Coast. Undoubtedly, efforts to stabilize the beach with seawalls, groins, and jetties in Texas and Louisiana have contributed to coastal erosion by depriving downdrift beaches of sediments, which accelerates erosion there (Morton, 1982), and by increasing or redirecting the erosional energy of waves. Over the last 20 years, dune and beach stabilization have been better accomplished by using more natural applications such as sand dunes, beach nourishment, and vegetative plantings.

A variety of beach and barrier island restorative measures have been brought about as the population has become more aware of barrier island and beach problems. During the mid-1980's, the U.S. Army Corps of Engineers contracted with the State of Louisiana and the Jefferson Parish governments to replenish beach sand on Grand Isle, Louisiana. During the 1990's, the State of Louisiana and Federal Government joined in a partnership through the Coastal Wetlands Protection, Planning and Restoration Act (CWPPRA) to address and, where possible, correct the deterioration of wetlands and barrier islands along Louisiana's Gulf Coast and elsewhere.

Sources and probabilities of oil entering waters of the Gulf and surrounding coastal regions are discussed in Chapter 4.1.3.4. Inland spills that do not occur in the vicinities of barrier tidal passes are more likely to contact the landward rather than the ocean side of a barrier island. Hence, no inland spills are expected to significantly contact barrier beaches (Chapters 4.2.1.1.1 and 4.3.1.1.1).

Most spills occurring in offshore coastal waters are assumed to proportionally weather and dissipate similar to the weathering described in Table 4-45. Dispersants are not expected to be used in coastal waters. The weathering model described in Chapter 4.4.1.1 attributes the dispersal of about 65 percent of the volume of a spill to the use of dispersants. No calculation has been made to estimate how much oil might be deposited on a beach if dispersants are not used. Unfavorable winds and currents would further diminish the volume of oil that might contact a beach. A persistent, northwesterly wind might preclude contact. As discussed in Chapters 3.2.1.1., 4.2.1.1.1, and 4.3.1.1.1, the probability that tide levels could reach or exceed the elevations of sand dune vegetation on barrier beaches ranges from 0 to 16 percent, depending on the particular coastal setting and the elevation of the vegetation. The strong winds that would be needed to produce unusually high tide levels would also disperse the slick over a larger area than is being considered in the current analysis. The probabilities of spill occurrence and contact to barrier beaches, and sand-dune vegetation are considered very low. Hence, contact of sand-dune vegetation by spilled oil is not expected to occur. Furthermore, the Mississippi River discharge would help breakup a slick that might otherwise contact Plaquemines Parish. The spreading would reduce the oil concentrations contacting the beach and vegetation, greatly reducing impacts on vegetation.

The barrier beaches of Deltaic Louisiana have the greatest rates of erosion and landward retreat of any known in the western hemisphere, and among the greatest rates on earth. Long-term impacts to contacted beaches from these spills could occur if significant volumes of sand were removed during cleanup operations. Removing sand from the coastal littoral environment, particularly in the sand-starved transgressive setting of coastal Louisiana, could result in accelerated coastal erosion. Spill cleanup is difficult in the inaccessible setting of coastal Louisiana. This analysis assumes that Louisiana would require the responsible party to clean the beach without removing significant volumes of sand or to replace the sand removed. Hence, cleanup operations are not expected to cause permanent effects on barrier beach stability. Within a few months, adjustments in beach configuration may result from the disturbance and movement of sand during cleanup.

The results of an investigation on the effects of the disposal of oiled sand on dune vegetation in Texas, showed no deleterious impacts on existing vegetation or colonization of the sand by new vegetation (Webb, 1988). Hence, projected oil contacts to small areas of lower elevation sand dunes are not expected to result in destabilization of the sand dune area or the barrier landform.

Some oil will penetrate to depths beneath the reach of the cleanup methods. The remaining oil would persist in beach sands, periodically being released when storms and high tides resuspend or flush through beach sediments. During hot, sunny days, tarballs buried near the surface of the beach sand may liquefy and cause a seep to the sand surface.

Many of the existing OCS-related and other pipeline landfalls have occurred on barrier landforms (Table 4-14 and Chapter 4.1.3.1.2). Construction of 23-38 new pipeline landfalls is expected as a result of the OCS Program (Chapter 4.1.2.1.7). An MMS study and other studies (Wicker et al., 1989; LeBlanc, 1985; Mendelssohn and Hester, 1988) have investigated the geological, hydrological, and botanical impacts of pipeline construction on and under barrier landforms in the Gulf. In general, the impacts of existing pipeline landfalls since 1975 were minor to nonexistent with current installation methods. In most cases, no evidence of accelerated erosion was noted in the vicinity of the canal crossings if no shore protection for the pipeline was installed on the beach and if no remnant of a canal remained landward of the beach. Wicker et al. (1989) warn that the potential for future breaching of the shoreline remains at the sites of flotation canal crossings where island width is small or diminishing because of erosion or the sediments beneath the sand-shell beach plugs are unconsolidated and susceptible to erosion.

Numerous pipelines have been installed on the bay side of barrier islands and parallel to the barrier beach. With overwash and shoreline retreat, many of these pipeline canals serve as sediment sinks, resulting in narrowing and lowering of barrier islands and their dunes and beaches. Such islands and beaches were rendered more susceptible to breaching and overwash. This type of pipeline placement was quite common in Louisiana, but has been discontinued.

An area of special concern along the south Texas coast is the Padre Island National Seashore, which is in coastal Subarea TX-1. At present, one OCS pipeline, which carries some condensate, crosses the northern end of Padre Island. For 2003-2042, 0-2 new pipeline landfalls are projected for coastal Subarea TX-1. Corpus Christi, north of Padre Island, is one of the possible shuttle tanker ports.

The contribution of the OCS Program to vessel traffic in navigation channels is described in Chapters 3.3.3.9.2 and 4.1.2.1.9. A portion of the impacts attributable to maintenance dredging and wake erosion of those channels would be in support of the OCS Program. Mitigative measures are assumed to occur, where practicable, in accordance with Executive Order 11990 (May 24, 1977). During the 40-year analysis period, beneficial use of dredged material may increase, thereby reducing the continuing impacts of navigation channels and jetties.

No new navigation channels between the Gulf and inland regions are projected for installation. The basis of this assumption is the large number of existing navigation channels that can accommodate additional navigation needs. Some new inland navigation channels will be dredged to accommodate the inland oil and gas industry, developers, and transportation interests. Some channels may be deepened or widened to accommodate projected increases in deeper-draft petroleum production and larger cargo vessels that are not related to OCS petroleum production.

Most barrier beaches in the CPA are relatively inaccessible for recreational use because they are either located a substantial distance offshore, as in Mississippi, or in coastal areas with limited road access, as in Louisiana. Few beaches in the CPA have been, or are likely to be, substantially altered to accommodate recreational or industrial construction projects in the near future.

Most barrier beaches in Texas, Alabama, and Florida are accessible to people for recreational use because of road access and their use is encouraged. The Texas Open Beaches Act (1959) guarantees the public's right to unimpeded use of the State's beaches. It also provides for public acquisition of private beach-front property. Recreational use of barrier beaches and dunes can have impacts on the stability of the landform. Vehicle and pedestrian traffic on sand dunes can stress and reduce the density of vegetation that binds the sediment and stabilizes the dune. Destabilized dunes are more easily eroded by winds waves and traffic. Judd et al. (1988) documented that as much as 18 percent of the total dune area along parts of South Padre Island had experienced damage from vehicular traffic. Recreational vehicles and even hikers have been problems where road access is available and where the beach is wide enough to support vehicle use, as in Texas, Alabama, Florida, and a few places in Louisiana. Areas without road access will have very limited impacts by recreational vehicles.

Summary and Conclusion

River channelization, sediment deprivation, and rapid submergence have resulted in severe, rapid erosion of most of the barrier and shoreline landforms along the Louisiana coast. The barrier system of coastal Mississippi and Alabama is well supported on a coastal barrier platform of sand. The Texas coast has experienced landloss because of a decrease in the volume of sediment delivered to the coast because of dams on coastal rivers, a natural decrease in sediment supply as a result of climatic changes during the past several thousand years, and subsidence along the coast.

Beach stabilization projects are considered by coastal geomorphologists and engineers to accelerate coastal erosion. Beneficial use of maintenance dredged materials could be required to mitigate some of these impacts.

The impacts of oil spills from both OCS and non-OCS sources to the sand-starved Louisiana coast should not result in long-term alteration of landform if the beaches are cleaned using techniques that do not significantly remove sand from the beach or dunes. The barrier beaches of deltaic Louisiana, the Chenier Plain, and the region around Galveston have the greatest risks of sustaining impacts from oil-spill landfalls because of their very high concentrations of oil production within 50 km of those coasts. The cleanup impacts of these spills could result in short-term (up to 2 years) adjustment in beach profiles and configurations as a result of sand removal and disturbance during cleanup operations. Some contact to lower areas of sand dunes is expected. These contacts would not result in significant destabilization of the dunes.

Under the cumulative scenario, new OCS-related and non-OCS pipeline landfalls are projected. These pipelines are expected to be installed using modern techniques, which cause little to no impacts to the barrier islands and beaches. Existing pipelines, in particular those that are parallel and landward of beaches, that had been placed on barrier islands using older techniques that left canals or shore protection structures have caused and will continue to cause barrier beaches to narrow and breach.

Recreational use of many barrier beaches in the Western Gulf is intense because of their accessibility by road. Because of the inaccessibility of most of the Central Gulf barrier coast to humans, recreational use is not expected to result in significant impacts to most beaches. Federal, State, and local governments have made efforts over the last 10 years to slow the landward retreat of Louisiana's Gulf shorelines.

In conclusion, coastal barrier beaches have experienced severe adverse cumulative impacts from natural processes and human activities. Natural processes are generally considered the major contributor to these impacts, whereas human activities cause both severe local impacts as well as the acceleration of natural processes that deteriorate coastal barriers. Human activities that have caused the greatest adverse impacts are pipeline canals, channel stabilization, and beach stabilization structures. Deterioration of Gulf barrier beaches is expected to continue in the future. Federal, Louisiana, and parish governments have made efforts over the last 10 years to slow the landward retreat of Louisiana's Gulf shorelines. The incremental contribution of a proposed action compared to cumulative impacts on coastal barrier beaches and dunes impacts is expected to be very small.

4.5.1.1. Wetlands

This cumulative analysis for the CPA and WPA considers the effects of impact-producing factors related to a proposed action, prior and future OCS sales, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes and events that may occur and adversely affect wetlands. As a result of these activities and processes, several impact-producing factors, discussed below, will contribute to impacts on wetlands and associated habitat during the life of the proposed actions. The effects of pipelines, canal dredging, navigation activities, and oil spills on wetlands are described in Chapters 4.2.1.1.2, 4.3.1.1.2, and 4.4.3.1.2. Other impact-producing factors and information relevant to the cumulative analysis are discussed below.

Many of man's activities have resulted in landloss either directly or indirectly by accelerating natural processes. Until the Mississippi River was channelized and leveed during the early 1900's, floodwaters layered sediment over the active Deltaic plain, countering ongoing submergence and also building new land. Areas that did not receive sediment-laden floodwaters continually lost elevation. Human intervention has interrupted the process of renewal. Further compounding this impact, the suspended sediment load in the Mississippi River has decreased more than 50 percent since the 1950's, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation practices in the drainage basin. Also, natural drainage patterns along many areas of the Texas coast have been severely altered by construction of the GIWW and other channelization projects associated with its development. Saltwater intrusion, as a result of river channelization and canal dredging, is a major cause of coastal habitat deterioration (including seagrass communities) (Tiner, 1984; National Wetlands Inventory Group, 1985; Cox et al., 1997). Productivity and species diversity associated with wetlands and submerged vegetated habitat in coastal marshes of Louisiana and Texas is greatly reduced by saltwater intrusion (Stutzenbaker and Weller, 1989; Cox et al., 1997).

Wetland loss rates in coastal Louisiana are well documented to be as high as 10,878 ha/yr (42 mi^2/yr) during the late 1960's. One analysis method indicated that the landloss rate in coastal Louisiana for the period 1972 to 1990, slowed to an estimated 6,475 ha/yr (25 mi^2/yr)(Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1993). A second methodology indicated a wetland loss rate of 9,072 ha/yr (35 mi^2/yr in the coastal zone of Louisiana during the period of 1978-1990 (USDOI, GS, 1998). Presuming that the landloss rate for that period is between that indicated by these two methods, approximately 7,776 ha (30 mi^2), and continues for the period 2002-2042, then 303,264 ha (1,170 mi^2) will have been lost. If the loss rate slows by 20 percent for the referenced period and given the apparent slowing trend, the loss could be as much as 242,611 ha or 936 mi^2 (for comparison purposes, the populated Greater New Orleans area is about 108,864 ha or 420 mi^2).

Development of wetlands for agricultural, residential, and commercial uses affects coastal wetlands. During the period 1952-1974 in the Chenier Plain area of southwestern Louisiana, an estimated 1,233 ha of wetlands were converted to urban use (Gosselink et al., 1979). During the period 1956-1978, an estimated 21,642 ha of urban or industrial development occurred in the Mississippi Deltaic Plain region of southern Louisiana (Bahr and Wascom, 1984). Submergence rates in coastal Louisiana have ranged from 0.48 to 1.3 cm per year (Baumann, 1980; Ramsey et al., 1991). This submergence is primarily due to subsidence and the elimination of river flooding. Flooding normally deposited sediment over the delta plains, which either slowed subsidence, maintained land elevations, or built higher land elevations, depending upon the distances from the river and the regularity of flooding for each region of interest. A secondary cause of land submergence is sea-level rise.

Wetland contacts by oil spills can occur from a number of sources. Chapter 4.1.3.4 provides an estimate of future spill risk. Their projected effects on wetlands are described in Chapter 4.4.3.1.2. The cumulative scenario discusses petroleum and products spills from all sources, inclusive of the OCS Program, imports, and State production. The large majority of oil slicks that contact land are expected to come ashore on barrier islands. Offshore spills from non-OCS sources are assumed to display similar spill dispersion and weathering characteristics to that of OCS-related spills.

Flood tides may bring some oil through tidal inlets into areas landward of barrier beaches. The turbulence of tidal water passing through most tidal passes would break up the slick, thereby accelerating dispersion and weathering. For the majority of these situations, light oiling of vegetated wetlands may occur, contributing less than 0.1 l/m^2 on wetland surfaces. Any adverse impacts that may occur to wetland plants are expected to be very short lived, probably less than one year.

Coastal OCS spills could occur as a result of pipeline accidents and barge or shuttle tanker accidents during transit or off-loading. The frequency, size, and distribution of all coastal spills is provided in Chapter 4.1.3.4. Impacts of OCS coastal spills are also discussed in Chapter 4.4.3.1. Non-OCS spills can occur in coastal regions as a result of import tankers, coastal oil production activities, and petroleum product transfer accidents. Their distribution is believed to be similar to that described in Chapter 4.4.3.1

Under this scenario, spills that occur in or near Chandeleur or Mississippi Sounds could potentially impact wetland habitat in or near the Gulf Islands National Seashore and the Breton National Wildlife Refuge and Wilderness Area. Because of their natural history, these areas are considered areas of special importance, and they support endangered and threatened species. Although the wetland acreage on these islands is small, the wetlands make up an important element in the habitat of the islands. Because the inlets that connect Mississippi Sound with the marsh-fringed estuaries and lagoons within the islands are narrow, a small percentage of the oil that contacts the Sound side of the islands will be carried by the tides into interior lagoons.

Discharging OCS-related produced water into inshore waters has been discontinued and all OCS-produced waters transported to shore will either be injected or disposed of in Gulf waters and will not affect coastal wetlands (Chapter 4.1.2.1.10).

Projected new onshore facilities for the CPA and WPA are described in Chapter 4.1.2.1 and Table 4-8. Federal and State permitting programs discourage facility placement in wetlands as much as is feasible; however, if the placement of a facility in a wetland is unavoidable, then adequate mitigation of all unavoidable impacts is required. Therefore, no significant impacts to wetlands are expected from construction of new facilities, other than the projected 0-1 pipeline landfalls for each proposed action.

Pipeline construction projects can affect wetlands in a number of ways. Pipeline installation methods and impacts are described in Chapters 4.1.2.1.7 and 4.1.3.1.2. The State oil and gas industry is generally described in Chapter 4.1.3.1. Two-thirds of OCS pipelines entering state waters tie into existing pipeline systems, and do not result in new landfalls. Of the 70-120 new OCS pipelines projected to enter state waters, only 23-38 will result in new landfalls. Landfalls are expected to initially impact an immeasurable area of wetland habitat. After backfilling, productivity of the impacted acreage would be repressed for up to 6 years, converting some wetland habitat to open water. Secondary impacts of canals are considered more damaging to coastal wetlands and associated habitats than primary construction impacts (Tabberer et al., 1985). Such impacts include expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment transport, and habitat conversion (Gosselink, 1984; Cox et al., 1997). Secondary wetland loss due to OCS-related pipeline and navigation canal widening is described in Chapters 4.2.1.1.2 and 4.3.1.1.2. The combined length of non-OCS pipelines through wetlands is believed to be approximately twice that of the Gulf OCS Program. In order to understand and report the impact of OCS activities, pipelines and navigational canal systems, their locations, routes and impacts must be identified and measured.

As a result of the OCS Program (2002-2043), up to 260 km of onshore pipeline are projected to be constructed in the WPA and CPA. Based on preliminary historic landloss results from the MMS/USGS NWRC current coastal pipeline impacts study for the Louisiana study area, the predicted landloss (based on an average of 4 ha of conversion to open water per linear km of pipeline (300-m buffer zone)) from the estimated 120-260 km of new OCS pipeline construction ranges from approximately 480-1,040 ha total over the 40-year analysis period. However, this estimate does not take into consideration the following variables:

- season of construction (growing vs. non-growing);
- precipitation and/or climatic conditions;
- mitigations applied by permitting agency;

- methods of construction/installation;
- size of pipeline; and
- location of construction and associated habitats impacted.

Also, the using of new technologies of pipeline construction, such as horizontal or trenchless directional drilling, would decrease impacts to sensitive habitat to as much as zero (0).

Pipeline maintenance activities that disturb wetlands are very infrequent and are considered insignificant. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements for canal and pipeline construction through wetlands. Maintenance of mitigation structures on pipeline canals is only required for 5 years (a rarely enforced stipulation). Structures constructed for the purpose of mitigating adverse impacts of pipeline construction frequently fail (Gosselink, 1984). Where mitigative structures are not regularly maintained, secondary impacts may hasten habitat loss to eventually equal or surpass the impacts that would have occurred had the structure not been installed. The nonmaintenance of mitigative structures can lead to their deterioration and eventual failure, allowing indirect and at times, adverse impacts on wetlands to proceed. These adverse impacts include saltwater intrusion, reduction of freshwater inflow, sediment erosion and export, expansion of tidal influence, and habitat conversion. The number of pipeline-related mitigative structures throughout coastal areas around the Gulf are unknown. Although the extent of impacts caused by failure to maintain mitigation structures is unknown, such impacts are believed to be significant (Gosselink, 1984; Tabberer et al., 1985; Turner and Cahoon, 1988).

Most canals dredged in coastal Louisiana and Texas have occurred as a result of onshore oil and gas activities. Drilling and production activity at most coastal well sites in Louisiana and Texas require rig access canals. Access canals and pipelines to service onshore development are pervasive throughout the coastal area in Louisiana; 15,285 km of pipeline canals have been installed to carry onshore production (USDOI, GS, 1984). Typical dimensions of an access canal, as indicated on permits during 1988, were 366-m long by 20-m wide with a 0.5-ha drill slip at the end.

In 1988, the U.S. Army Corps of Engineers (COE) received applications for the installation of 123 km of pipelines and for dredging more than 11 km of new oil-well access canals through wetland areas. This survey took place during a period (1984 through 1990) of suppressed oil and gas activities. Assuming that this level of activity persists for the period 2002-2042, the direct impacts from the COE-permitted dredging are hard to measure but may lead to the conversion of wetland habitat to open water. Additionally, more wetland habitat will be buried by spoil banks along the channel margins, converting some wetlands acreage to bottom land or shrub-scrub habitat.

As discussed in Chapter 4.1.1, the magnitude of future OCS activities is being directed towards deeper water, which may require larger service vessels for efficient operations. Ports housing OCS-related service bases that can accommodate deeper-water vessels are described in Chapter 4.1.2.1. Empire and Cameron, Louisiana, are considered marginally useable for OCS-related, shallow water traffic.

Ports containing service bases with access channels less than 4.5 m (15 ftz) deep may decide to deepen their channels to capture portions of OCS activities projected for deep water. Typically, channels greater than 6-7 m deep will not be needed to accommodate the deepwater needs of the OCS Program. Channels deeper than 6-7 m accommodate increasing numbers of ocean-going ships. The Corpus Christi, Houston, and Mississippi River ship channels are being considered for deepening to allow access by larger ocean-going vessels that are not related to the OCS Program. Since the Port Authority of Lafourche Parish and the COE have deepened access and interior channels of Port Fourchon to greater than 7 m NGVD, the numbers of cargo vessels not related to petroleum or fishing using Port Fourchon are projected to increase in the future. Increased population and commercial pressures on the Mississippi Gulf Coast are also causing pressures to expand ports there.

Materials dredged to deepen channels in Port Fourchon are expected to be placed to create development sites and 192 ha of saline marsh. The feasibility report anticipates no significant saltwater intrusion effects on wetlands as a result of the deepening project, probably because the project only extends approximately 8.5 km inland and will be performed in a saline environment where the existing vegetation is salt tolerant (Chapters 4.2.1.1.2 and 4.3.1.1.2 for details).

Deepening the Corpus Christi Ship Channel from -13.7 to -15.2 m NGVD is expected to displace approximately 353 million m^3 in an open bay system. The recent dredging and deepening of this channel to -13.7 m NGVD caused no significant saltwater intrusion. The dredged material generated by the deepening project will be used to enhance and create wetlands rather than be disposed of onto spoil banks adjacent to the channel. No significant adverse impacts to wetlands are expected to result from the project.

Vessel traffic within navigation channels can cause channel bank erosion in wetland areas. Tables 3-30 and 3-31 show vessel traffic using OCS-related waterways in 1999. Approximately 10 percent of the traffic using OCS-related channels is related to the OCS Program. Much of the length of these channels are through eroding canals, rivers, and bayous. Non-OCS-related navigation channels are believed to conduct lower traffic volumes and, therefore are expected to widen at a lower rate of as much as 0.95 m/yr. Maintenance dredging of existing channels will occur and could harm wetlands if the dredged material is deposited onto wetlands, resulting in burial or impoundment of marsh areas. This analysis assumes an increasing implementation of dredged material disposal for wetland enhancement and creation during the life of a proposed action. Ten percent of associated maintenance dredging of OCS-related channels and related impacts are attributed to the OCS Program. On average, every two years the four COE Districts survey the navigation channels they are responsible for to determine the need for maintenance dredging. Schedules for maintenance dredging of OCS-related navigation channels vary broadly from once per year to once every 17 years. Each navigation channel is typically divided into segments called "reaches." Each reach may have a maintenance schedule that is independent of adjacent reaches. COE data indicates an approximate average of 14,059,500 m^3 per year or 492,082,500 m^3 per 35 years are displaced by maintenance dredging activities on OCS-related navigation channels in the Gulf area; this roughly amounts to approximately 144,700 m^3 per kilometer.

Navigation channels not used by OCS navigation traffic are generally smaller, less-used channels with less frequent maintenance dredging. These channels are expected to produce 50 percent less maintenance-dredged materials per kilometer. Hence, maintenance dredging of non-OCS-related channels are estimated to produce approximately 36,576,500 m^3 of material during the period 2003-2042. This dredged material could be used to enhance or re-establish marsh growth in deteriorating wetland areas. If implemented, the damaging effects of maintenance dredging of navigation channels would be reduced.

Specific to navigation channels are the effects from saltwater intrusion (Gosselink et al., 1979; Wang 1987). Wang (1987) developed a model demonstrating that, under certain environmental conditions, salt water penetrates farther inland in deep navigation channels than in shallower channels, suggesting that navigation channels act as "salt pumps." The Calcasieu Ship Channel is a good example of how saltwater intrusion, as a consequence of channelization, results in significant habitat transition from freshwater to brackish and ultimately to salt or open-water systems. Another example is the construction of the Mississippi River Gulf Outlet that led to the transition of many of the cypress swamps east of the Mississippi River below New Orleans to open water or areas largely composed of marsh vegetation (*Spartina)* with old, dead cypress tree trunks.

Significant volumes of OCS-related produced sands and drilling fluids will be transported to shore for disposal. According to USEPA information, sufficient disposal capacity exists at operating and proposed disposal sites. Economic and political opportunities exist that may support construction of new disposal sites. Because of current regulatory policies, no wetland areas will be disturbed as a result of the establishment of new disposal sites or expansions or existing sites, without adequate mitigation. Some seepage from waste sites may occur into adjacent wetland areas and result in damage to wetland vegetation.

Miscellaneous factors that impact coastal wetlands include marsh burning, marsh buggy traffic, onshore oil and gas activities, and well-site construction. Bahr and Wascom (1984) report major marsh burns that have resulted in permanent wetland loss. Sikora et al. (1983) reported that in one 16-km^2 wetland area in coastal Louisiana, 18.5 percent of the area was covered with marsh-buggy tracks. Tracks left by marsh buggies have been known to open new routes of water flow through relatively unbroken marsh, thereby inducing and accelerating erosion and sediment export. Marsh-buggy tracks are known to persist in Louisiana intermediate, brackish, and saline marshes for 15-30 years. Well-site construction activities include board roads and ring levees. Ring levees are approximately 1.6-ha impoundments constructed around a well site. In oil and gas fields, access canal spoil banks impound large areas of wetlands. The total acreage of impounded, dredged, and filled wetlands from drilling onshore coastal wells is considered substantial.

Current Mitigation Techniques Used to Reduce Adverse Impacts to Wetlands

Despite a national goal to achieve "no net loss of the . . . wetlands base," there is no one single law that protects wetlands (Strand, 1997). Instead, numerous regulatory mechanisms, combined with a well-defined mitigation process, are used to encourage wetland protection. The Clean Water Act's Section 404 dredge and fill permit program is the strongest regulatory tool protecting wetlands from impacts; however, the key component of Section 404 is the requirement that adverse ecological impacts of a development project be mitigated by the developing agency (for OCS pipeline landfalls, this is the Corps of Engineers) or individual. The core of wetland protection revolves around the ability to mitigate or minimize impacts to wetlands and other sensitive coastal habitat.

Mitigation or the minimization of wetland impacts is particularly relevant along the northern coast of the GOM, specifically Louisiana, where significant impacts from human activities related to the oil and gas industry occur in wetland systems. As researchers document the direct and indirect consequences of pipelines canals, dredging, and dredged material placement on wetland systems, optimizing old mitigation techniques and identifying new mitigation techniques in order to reduce impacts as much as possible is a necessary component of any development plan that terminates onshore. With more than 16,000 km (about 10,000 mi) of pipelines along the coast of the northern GOM (Johnson and Cahoon, in review), and the extent to which activities related to these pipelines and any new pipelines are mitigated, may be crucially important to the long-term integrity of the sensitive habitats (i.e., wetlands, shorelines, and seagrass communities) in these sensitive and fragile areas.

The following information identifies and documents the use and effectiveness of mitigation techniques related to OCS pipelines, canals, dredging, and dredged material placement in coastal habitats along the northern coast of the GOM and associated with the proposed action. The material will provide an overview and discussion of mitigation techniques that have been studied and used, as well as new and modified mitigation techniques that may not be well documented.

Mitigation Defined

The Council on Environmental Quality (1978) defined mitigation as a five-step process

(1) Avoidance – the avoiding of the impact altogether by not taking a certain action or part of an action

(2) Minimization – the minimizing of impacts by limiting the degree or magnitude of the action and its implementation

(3) Restoration – the rectifying of the impact by repairing, rehabilitating, or restoring the affected environment

(4) Preservation through Maintenance – the reducing or eliminating of the impact over time by preservation and maintenance operations during the life of the action

(5) Compensation – the compensating for the impact by replacing or providing substitute resources of environments

Mitigation History Related to Oil and Gas Activities

Mitigation of wetland impacts from oil and gas activities has a very short history. Prior to the 1980's, wetlands were not protected and very little attention was paid to the environmental impacts of pipeline construction within wetland areas. Focus was on deciding the best (fastest and most economical) way to install the pipelines in soft sediment. With more recent requirements for considering impacts to sensitive coastal habitat, methods and techniques for mitigation impacts have developed and refined.

Because of the extensive coastal wetland systems along the northern coast of the GOM, avoidance of wetland systems is often impossible for pipelines related to OCS activities. Thus, minimization is the main focus of mitigation for pipeline-related activities. Numerous suggestions for minimization impacts have been recommended with some of the most promising ideas emerging based on past experience and field observations.

Overview of Existing Mitigation Techniques and Results

Numerous mitigation methods have been recommended and used in the field. Depending on the location, the project in question, and the surrounding environment, different mitigation techniques may be more appropriate over another. Based on permits, work documents, and interviews, 17 mitigation techniques have been implemented at least once, with no one technique or suite of techniques routinely required by permitting agencies; each pipeline mitigation process is uniquely designed to minimize damages given the particular setting and equipment to be installed. Of the identified mitigation techniques, there are, however, a number of techniques that are commonly required, while others are rarely used either because they are considered obsolete in most instances or because they are applicable only to a narrow range of settings. Table 4-63 highlights and summarizes technical evidence for the use of various mitigating processes associated with pipeline construction, canals, dredging, and dredged material placement.

Summary

Mitigation of impacts from OCS pipelines, canals, dredging, and dredged material placement evolved with the growing environmental protection laws in the United States. The "avoid, minimize, restore, and compensate" sequence has become an automatic series of events in project planning. Unfortunately, best professional judgment remains the primary guide for decisionmakers. There is no quantitative, hard evidence of the reduction in impacts as a result of any one of the many mitigation techniques.

Sources of Available Funding for Wetland Restoration

The Coastal Impact Assistance Program (CIAP) has been authorized by Congress to assist states in mitigating the impacts associated with OCS oil and gas production. Congress has appropriated approximately $150 million to the National Oceanic Atmospheric Administration (NOAA) to be allocated to Texas and Louisiana as well as five other coastal states. The money is to be used to undertake a variety of projects for protecting and restoring coastal resources and mitigating the impacts of OCS leasing and development. The Texas General Land Office and the Louisiana Department of Natural Resources are coordinating their states efforts in acquiring their proportion of these funds.

In addition to the CIAP, the Gulf of Mexico Program (GMP) sponsors the Gulf Ecological Management Site (GEMS) program. The GEMS program is an initiative of the GMP and the five Gulf of Mexico states providing a framework for ecologically important Gulf habitats. The GEMS program coordinates and utilizes existing Federal, State, local, and private programs, resources, and mechanism to identify GEMS in each state. Each Gulf State has identified special ecological sites it regards as GEMS. Louisiana and Texas have identified the areas as GEMS (see Table 4-52).

Summary and Conclusion

Impacts from residential, commercial, and agricultural and silvicultural (forest expansion) developments are expected to continue in coastal regions around the Gulf. Existing regulations and development permitting procedures indicate that development-related wetland loss may be slowed and that very few new onshore OCS facilities, other than pipelines, will be constructed in wetlands.

Impacts from State onshore oil and gas activities are expected to occur as a result of dredging for new canals and for maintenance, usage of existing rig access canals and drill slips, and preparation of new well sites. Indirect impacts from dredging new canals for State onshore oil and gas development (Chapter 4.1.3.1) and from maintenance of the existing canal network is expected to continue.

Maintenance dredging of the OCS-related navigation channels displaces approximately 492,082,500 m^3, of which 10 percent is attributed to the OCS Program. Federally maintained, non-OCS-related navigation channels are estimated to account for another estimated 36,576,500 m^3 of dredged material. Maintenance dredging of inshore, well-access canals is estimated to result in the displacement of another 5,014,300 m^3 of materials. Insignificant adverse impacts upon wetlands from maintenance dredging are expected because the large majority of the material would be disposed upon existing disposal areas. Alternative dredged material disposal methods can be used to enhance and create coastal wetlands.

Depending upon the regions and soils through which they were dredged, secondary adverse impacts of canals can be much more locally significant and boarder than direct impacts. Additional wetland losses generated by the secondary impacts of saltwater intrusion, flank subsidence, freshwater-reservoir reduction, and deeper tidal penetration have not been calculated due to a lack of quantitative documentation; the MMS has initiated a project to document and develop data concerning such losses. A variety of mitigation efforts are initiated to protect against direct and indirect wetland loss. The non-maintenance of mitigation structures that reduce canal construction impacts can have substantial impacts upon wetlands.

In Louisiana, deepening Fourchon Channel to accommodate larger, OCS-related service vessels has occurred within a saline marsh environment and will afford the opportunity for the creation of wetlands with the dredged materials. Also, deepening the Corpus Christi and Houston Ship Channels is non-OCS-related and should also afford the opportunity to create wetlands with dredged material. A variety of non-OCS-related pressures are generating a need to expand ports on the Mississippi Gulf Coast.

In conclusion, based on preliminary historic landloss results from the MMS/USGS NWRC current coastal pipeline impacts study for the Louisiana study area, the predicted landloss from the estimated 120-260 km of new OCS pipeline construction ranges from approximately 480-1,040 ha total over the 40-year analysis period. The current MMS/USGS pipeline study is continuing to develop models that will aid in quantifying habitat loss associated with OCS activities. The CPA and WPA proposed actions represent about 2 and 1 percent, respectively, of the OCS impacts that will occur during the period 2003-2042. Deltaic Louisiana is expected to continue to experience the greatest loss of wetland habitat. Wetland loss is also expected to continue in coastal Texas, Mississippi, Alabama, and Florida, but at slower rates.

4.5.1.2. Seagrass Communities

This cumulative analysis considers the effects of impact-producing factors related to the WPA and CPA proposed action, prior and future OCS activities, State oil and gas activities, other governmental and private projects and activities, and pertinent natural processes and events that may adversely affect seagrass communities and associated habitat during the life of a proposed action. The cumulative effects of pipelines, canal dredging, scaring from vessel traffic, and oil spills on seagrass communities and associated habitat are described in Chapters 4.2.1.1.3, 4.3.1.1.3, and 4.4.3.1.3. In addition to the above stated impacts, other impact-producing factors (channelization) relevant to the cumulative analysis are discussed below.

Pipelines

Pipeline construction projects can affect seagrass habitats in a number of ways, however, maintenance activities that disturb wetlands and associated habitat (submerged vegetation and seagrass beds) are very infrequent and considered insignificant. During reviews of pipeline projects for Federal and State permits, agencies consistently comment with concern upon the extent of secondary impacts. As a result, structures engineered to mitigate secondary adverse impacts are included as permit requirements for canal and pipeline construction. Pipeline installation methods and impacts to submerged vegetation are described in Chapters 4.1.2.1.7, 4.2.1.1.3, and 4.3.1.1.3. The State oil and gas industry is generally described in Chapter 4.1.3.1.2. There are 126 existing pipeline landfalls related to the OCS Program with 23-38 new pipeline landfalls from 2003-2042. There are 70-120 new OCS pipelines projected to enter state waters, however two-thirds of OCS pipelines entering state waters tie into existing pipeline systems, and will not result in new landfalls.

Dredging, Channelization, and Water Controls

Dredge and fill activities are the greatest threats to submerged vegetation and seagrass habitat (Wolfe et al., 1988). Existing and projected lengths of OCS-related pipelines and OCS-related dredging activities are described in Chapters 4.1.2.1.7 and 4.1.3.3.3. The dynamics of how these activities impact submerged vegetation is discussed in Chapters 4.2.1.1.3 and 4.3.1.1.3. The most serious impacts to submerged vegetation and associated seagrass communities generated by dredging activities are a result of removal of sediments, burial of existing habitat, and oxygen depletion and reduced light attenuation associated with increased turbidity. Turbidity is most damaging to beds in waterbodies that are enclosed, have relatively long flushing periods, and contain bottom sediments that are easily resuspended for long periods of time. An integrative model of seagrass distribution and productivity produced by Dunton et al. (1998) strongly suggests light attenuation due to dredging operations that increases turbidity will negatively impact seagrass health.

Dredging impacts associated with the installation of new navigation channels are greater than those for pipeline installations, because new canal dredging creates a much wider and deeper footprint. A greater amount of material and fine materials are disturbed; hence, turbidity in the vicinity of canal dredging is much greater, persists for longer periods of time, and the turbidity extends over greater distances and acreage. New canals and related disposal of dredged material also cause significant changes in regional hydrodynamics and associated erosion. Significant and substantial secondary impacts include wake erosion resulting from navigational traffic as evident along the Texas coast where heavy traffic utilizing the Gulf Intracoastal Waterway (GIWW) has accelerated erosion of existing salt marsh habitat (Cox et al., 1997). New canals can also encourage additional development.

Most impacts to lower-salinity species of submerged vegetation and seagrass communities by new channel dredging within the cumulative activity area have occurred in Louisiana and Texas. This will continue to be the case in the foreseeable future. Similarly, most impacts to higher-salinity species of submerged vegetation have occurred in Florida, where seagrass beds are more abundant. Reduction of submerged vegetation in the bays of Florida is largely attributed to increased turbidity, primarily due to dredge and fill activities (Wolfe et al., 1988). Channel dredging to facilitate, create, and maintain waterfront real estate, marinas, and waterways will continue to be a major impact-producing factor in the proposed cumulative activity area.

The waterway maintenance program of the COE has been operating in the cumulative activity area for decades (Chapter 4.1.2.1.9). Impacts generated by initial channel excavations are sustained by regular maintenance activities performed every 2-5 years, or perhaps less frequently. The patterns of submerged vegetation and seagrass beds have adjusted accordingly. Maintenance activities are projected to continue into the future regardless of the OCS activities. If the patterns of maintenance dredging change, then the patterns of submerged vegetation distribution may also change.

In areas where typical spoil banks are used to store dredged materials, the usual fluid nature of mud and subsequent erosion causes spoil bank widening, which may bury nearby waterbottoms and submerged vegetation/seagrass beds. Those waterbottoms may become elevated, converting some nonvegetated waterbottoms to shallower waterbottoms that may become vegetated due to increased light at the new soil surface. Some of these waterbottoms may also be converted to wetlands, or even uplands, by the increased elevation.

Plans for installation of new linear facilities and maintenance dredging are reviewed by a variety of Federal, State, and local agencies, as well as by the interested public for the purposes of receiving necessary government approvals. Mitigation may be required to reduce undesirable impacts. The most effective mitigation for direct impacts to seagrass beds and associated habitat is avoidance with a wide berth around them. Using turbidity curtains can also control turbidity.

Many of man's activities have caused landloss either directly or indirectly by accelerating natural processes. Until the Mississippi River was channelized and leveed during the early 1900's, floodwaters layered sediment over the active Deltaic plain, countering ongoing submergence and also building new land. Areas that did not receive sediment-laden floodwaters continually lost elevation. Human intervention interrupted this process of renewal. Further compounding this impact, the suspended sediment load in the Mississippi River has decreased more than 50 percent since the 1950's, largely as a result of dam and reservoir construction (Turner and Cahoon, 1988) and soil conservation practices in the drainage basin. Also, natural drainage patterns along many areas of the Texas coast have been severely altered by construction of the GIWW and other channelization projects associated with its development. Saltwater intrusion, as a result of river channelization and canal dredging, is a major cause of coastal habitat deterioration (including seagrass communities) (Tiner, 1984; National Wetlands Inventory Group, 1985). Productivity and species diversity associated with submerged vegetated habitat in coastal marshes of Louisiana and Texas is greatly reduced by saltwater intrusion (Stutzenbaker and Weller, 1989).

Leveeing (or banking) and deepening of the Mississippi River has affected seagrass communities in the Mississippi and Chandeleur Sounds by reducing freshwater flows and flooding into those estuaries and by raising average salinities there. Due to increased salinities, some species of submerged vegetation including seagrass beds are able to populate areas farther inland, where sediment conditions are not as ideal. If the original beds are then subjected to salinities that are too high for their physiology, the vegetation will die which affects the habitat associated with the seagrass beds, e.g., nursery habitat for juvenile fish and shrimp. In turn, freshwater inflow increases around the mouths of rivers that have been modified for flood control, hence, beds of submerged vegetation may become established farther seaward if conditions are favorable. If the original beds are then subjected to salinities that are too low for their physiology, the vegetation will die. These adjustments have occurred in the cumulative activity area, particularly when high-water stages in the Mississippi River cause the opening of the Bonnet Carre' Spillway to divert flood waters into Lake Pontchartrain. This freshwater eventually flows into Mississippi and Chandeleur Sounds, lowering salinities there. In the past, spillway openings have been associated with as much as a 16 percent loss in seagrass vegetation acreage (Eleuterius, 1987). Conversely, the Caernarvon Freshwater Diversion into the Breton Sound Basin, east of the River, provides more regular flooding events, which have reduced average salinities there. Reduced salinities there have triggered a large increase in acreage of submerged freshwater vegetation. Seagrass communities may then reestablish in regions that were previously too saline for them.

Scarring

The scarring of seagrass beds by vessels (including various support vessels for OCS and State oil and gas activities, fishing vessels, and recreational watercraft) is an increasing concern along the Texas coast. Scarring most commonly occurs in seagrass beds that occur in water depths shallower than 6 ft as a result of boats of all classes operating in water that is too shallow for them. Consequently, their propellers and occasionally their keels plow though shallow water bottoms, tearing up roots, rhizomes, and whole plants, leaving a furrow that is devoid of seagrasses ultimately destroying essential nursery habitat. Other causes include anchor drags, trawling, trampling, and loggerhead turtles (especially in seagrass habitat of the coast of Florida) (Sargent et al., 1995; Preen, 1996). Recently, seismic activity in areas supporting seagrass nursery habitat has become a focus of concern for Texas state agencies. Although the greatest scarring of seagrasses has resulted from smaller boats operating in the vicinities of the greatest human population and boat registration densities, the greatest single scars have resulted from commercial vessels. Scarring may have a more critical effect on habitat functions in areas with less submerged vegetation. A few local and state governments in the Coastal Bend area of Texas have instituted management programs to reduce scarring. These programs include education, channel marking, increased enforcement, and limited-motoring zones. Initial results indicate that scarring can be reduced.

Oil Spills

Because of the floating nature of oil and the regional microtidal range, oil spills alone would typically have very little impact on seagrass communities and associated epifauna. Increased wave action can increase impacts to submerged vegetation and the community of organisms that reside in these beds by forcing oil from the slick into the water column. Unusually low tidal events would also increase the risk of oil having direct contact with the vegetation. Even then, epifauna residing in these seagrass beds would be more heavily impacted than the vegetation itself. Oiling of seagrass beds would result in die-back of the vegetation and associated epifauna, which would be replaced for the most part in 1-2 growing seasons, depending upon the season in which the spill occurs. Although little or no direct mortality of seagrass beds is expected as a result of oil-spill occurrences, contact of seagrasses with crude or refined oil products has been implicated as a causative factor in the decline of seagrass beds and in the observed changes in species composition within them (Eleuterius, 1987). Cleanup of slicks in shallow, protected waters (less than 5 ft deep) can cause significant scarring and trampling of submerged vegetation beds.

Oil spilled in Federal offshore waters is not projected to significantly impact submerged aquatic vegetation, which includes seagrass communities. In contrast and based on information presented in Chapter 4.1.2.1.5.1, oil spills from inland oil-handling facilities and navigational traffic has a greater potential for impacting wetlands and seagrass communities. Given the large number of existing oil wells and pipelines in eastern coastal Louisiana and the volumes of oil piped through that area from the OCS, the risk of oil-spill contacts to the few seagrass beds in that vicinity would be much higher than elsewhere in the cumulative activity area.

Summary and Conclusion

Dredging generates the greatest overall risk to submerged vegetation. Dredging causes problems for beds of submerged vegetation. These actions uproot, bury, and smother plants as well as decrease oxygen in the water and reduce the amount of necessary sunlight. Channel dredging to create and maintain waterfront real estate, marinas, and waterways will continue to cause the greatest impacts to higher salinity submerged vegetation.

The oil and gas industry and land developers perform most new dredging in the cumulative activity area. Within the cumulative activity area, most dredging that impacts lower salinity submerged vegetation has occurred in Louisiana and Texas in support of inshore petroleum development. Cumulatively, offshore oil and gas activities are projected to generate another 19-32 pipeline landfalls in Texas and Louisiana. Mitigation may be required to reduce undesirable impacts of dredging to submerged vegetation. Maintenance dredging of navigation channels may sustain the impacts of original dredging. The most effective mitigation for direct impacts to submerged vegetation beds is avoidance, as well as the use of turbidity curtains to reduce turbid conditions.

Large water control structures associated with the Mississippi River influence salinities in coastal areas, which in turn influences the location of seagrass communities and associated epifauna. Where flooding or other freshwater flow to the sea is reduced, regional average salinities generally increase. Average salinities in areas of the coast that receive increased freshwater flows as a result of the above flood controls are generally reduced. Beds of submerged vegetation (seagrass) adjust their locations based on their salinity needs. If the appropriate salinity range for a species is located where other environmental circumstances are not favorable, the new beds will be either smaller, less dense, or may not colonize at all.

When the Mississippi River is in flood condition, floodways may be opened to alleviate the threat of levee damage. The floodways of the Mississippi River direct water to estuarine areas where flood waters may suddenly reduce salinities for a couple of weeks to several months. This lower salinity can damage or kill high-salinity seagrass beds if low salinities are sustained for longer periods than the seagrass species can tolerate. Opening one of the floodways of the Mississippi River is the single action that can adversely impact the largest areas of higher-salinity submerged vegetation.

Inshore oil spills generally present greater risks of adversely impacting submerged vegetation and seagrass communities than do offshore spills for the areas in a proposed action (Mississippi, Louisiana, and Texas). Given the large number of existing oil wells and pipelines in and near Chandeleur Sound and the designation by the OSRA analysis that Plaquemines Parish has one of the highest probabilities that a spill ≥1,000 bbl will make landfall, the risk of numerous contacts to seagrass beds in this vicinity may be high. Such contacts will result in die back to the seagrass vegetation and supported epifauna, which will be replaced for the most part within one to two growing seasons, depending upon the season in which the spill occurs. Although zero to little direct permanent mortality of seagrass beds is expected as a result of oil-spill occurrences, contact of seagrasses with crude and refined oil has been implicated as a causative factor in the decline of seagrass beds and in the observed changes in species composition within them (Eleuterius, 1987).

Because of the floating nature of oil and the microtidal range that occurs in this area, oil spills alone would typically have very little impact on seagrass beds and associated epifauna. Unusually low tidal events, increased wave energy, or the use of oil dispersants increase the risk of impact. Usually, epifauna residing within the seagrass beds is much more heavily impacted than the vegetation. The cleanup of slicks can cause significant scarring and trampling of submerged vegetation and seagrass beds while the slick is over shallow, protected waters that are less than 5-ft deep.

Seagrass communities and associated habitat can be scarred by anchor drags, trampling, trawling, loggerhead turtles, occasional seismic activity, and boats operating in water that is too shallow for their keels or propellers. These actions remove or crush plants. The greatest scarring results from smaller boats operating in the vicinities of larger populations of humans and registered boats. A few State and local governments have instituted management programs that have resulted in reduced scarring.

In general, a proposed action would cause a minor incremental contribution to impacts to submerged vegetation due to dredging, boat scarring, pipeline installations and possibly oil spills. Because channel maintenance, land development, and flood control will continue, with only minor impacts attributable to OCS activities, a proposed action would cause no substantial incremental contribution to these activities or to their impacts upon submerged aquatic vegetation or seagrass communities.

4.5.2. Impacts on Sensitive Offshore Resources

4.5.2.1. Live Bottoms (Pinnacle Trend and Topographic Features)

Pinnacle Trend

This cumulative analysis considers the effects of impact-producing factors related to the proposed actions plus those related to prior and future OCS lease sales, and to tanker and other shipping operations that may occur and adversely affect live bottoms (low-relief and pinnacle trend features). Specific OCS-related impact-producing factors considered in the analysis are structure emplacement and removal, anchoring, discharges from well drilling, produced waters, pipeline emplacement, oil spills, blowouts, and operational discharges by tanker ships. Non-OCS-related impacts, including commercial fisheries, natural disturbances, additional anchoring by recreational boats, and other non-OCS commercial vessels, as well as spillage from import tankering, all have the potential to alter live bottoms.

It is assumed protective stipulations for live bottoms and the pinnacle trend will be part of appropriate OCS leases and existing site/project-specific mitigations will be applied to OCS activities on these leases or supporting activities on these leases. Stipulations and mitigations require operators to do the following:

- locate potential individual live bottoms and associated communities that may be present in the area of proposed activities and,
- protect sensitive habitat potentially impacted by OCS activities by requiring appropriate mitigation measures.

Stipulations and mitigations do not protect the resources from activities outside the MMS jurisdiction (i.e., commercial fishing, tanker and shipping operations, or recreational activities).

Most non-OCS activities have a greater potential to affect the hard-bottom communities of the region. Recreational boating and fishing, import tankering, and natural events such as extreme weather and fluctuations of environmental conditions (e.g., nutrient pulses, low dissolved oxygen levels, seawater temperature minima, and seasonal algal blooms) may severely impact low-relief, live-bottom communities of the CPA. There are no known pinnacle features located within the boundaries of the WPA. In addition, ships anchoring near major shipping fairways of the CPA, on occasion, may impact sensitive areas located near these fairways. Numerous fishermen also take advantage of the relatively shallow and easily accessible resources of the region and anchor at hard-bottom locations to fish. This is particularly the case in the pinnacle trend area. Therefore, several instances of severe and permanent physical damage to the pinnacle features and the associated live bottoms could occur as the result of non-OCS activities. It is assumed that biota associated with live bottoms of the CPA are well adapted to many of the natural disturbances mentioned above. A severe human disturbance, however, could cause important damage to live-bottom biota, possibly leading to changes of physical integrity, species diversity, or biological productivity exceeding natural variability. If such an event were to occur, recovery to pre-impact conditions could take as much as 10 years.

As with anchoring, the placement of drilling rigs and production platforms on the seafloor crushes the organisms directly beneath the legs or mat used to support the structure. The areas affected by the placement of the rigs and platforms would predominantly be soft-bottom regions where the infaunal and epifaunal communities are ubiquitous. Because of local bottom currents, the presence of conventional bottom-founded platform structures can cause scouring of the surficial sediments (Caillouet et al., 1981).

Structure placement and anchor damage from support boats and ships, floating drilling units, and pipeline-laying vessels disturb areas of the seafloor. These disturbances are considered the greatest OCS-related threat to live-bottom areas. The size of the areas affected by chains associated with anchors and pipeline-laying barges would depend on the water depth, chain length, sizes of anchor and chain, method of placement, wind, and current. Anchor damage could include crushing and breaking of live/hard bottoms and associated communities. Anchoring often destroys a wide swath of habitat when a vessel drags or swings at anchor, causing it to drag the seafloor. The biological stipulations limit the proximity of new activities to live bottoms and sensitive features. Platforms are required to be placed away from live bottoms thus, anchoring events near platforms are not expected to impact the resource. Accidental anchoring could severely impact hard-bottom substrate with recovery rates (which are not well documented) estimated at 5-20 years depending on the severity.

Both explosive and nonexplosive structure-removal operations disturb the seafloor and can potentially affect nearby live/hard-bottom communities. Structure removal using explosives (the most common removal method) can suspend sediments, which settle much in the same manner as discussed below for muds and cuttings discharges. Individual charges used in OCS structure removals are required to be 23 kg (50 lb) or less, and are detonated 5 m below the mudline, which may attenuate shock waves in the seafloor within less than 100 m from the structure (Baxter et al., 1982). Sessile and other benthic organisms are known to resist the concussive force of structure-removal-type blasts. Sediment resuspension associated with structure removals would not last long and in some cases, does not occur at all (Gitschlag, personal communication, 2001). Resuspended sediments would impact an area within a radius of approximately 1,000 m. Therefore, the explosive removal of structures is not expected to effect these sensitive areas. Should low-relief, hard-bottom communities incur any damages as a result of the explosive removal of structures, impacts would include restricted cases of mortality, and the predicted recovery to pre-impact conditions would be accomplished in less than 10 years.

Routine discharges of drilling muds and cuttings by oil and gas operations could affect biological communities and organisms through a variety of mechanisms, including the smothering of organisms through deposition or less obvious sublethal toxic effects (impacts to growth and reproduction). The protective lease stipulations and site-specific mitigations would prevent drilling activities and drilling discharges from occurring directly over pinnacle features or associated habitat. Drilling discharges should reach undetectable concentrations in the water column within 1,000 m of the discharge point, thus limiting potential toxic effects to any benthic organisms occurring within a 1,000 m radius from the discharge point. Any effects would be expected to diminish with increasing distance from the discharge area. Although Shinn et al. (1993) found detectable levels of metals from muds out to 1,500 m from a previously drilled well site in the pinnacle trend area, the levels of these contaminants in the water column and sediments are expected to be much lower than those known to have occurred in the past due to new USEPA discharge regulations and permits (Chapter 4.1.1.3.4). Regional surface currents and the water depth (>40 m) would greatly dilute the effluent. Deposition of drilling muds and cuttings in live-bottom and pinnacle trend areas are not expected to greatly impact the biota of the pinnacles or the surrounding habitat. Furthermore, because the biota of the seafloor surrounding the pinnacles are adapted to life in turbid (nepheloid) conditions and high sedimentation rates in the western portions of the pinnacle trend area, deposition and turbidity caused by a nearby well should not adversely affect this sensitive environment. The impact from muds and cuttings discharged as a result of the cumulative scenario would be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Recovery to pre-impact conditions from these sublethal impacts would take place within 10 years.

The depth of the low relief hard bottoms (>40 m), currents, and offset of discharges of produced waters and domestic and sanitary wastes (required by lease stipulations and postlease mitigations) would result in the dilution of produced waters and wastes to harmless levels before reaching any of the live bottom. Adverse impacts from discharges of produced waters and domestic and sanitary wastes as a result of the cumulative case would therefore be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Predicted recovery to pre-impact conditions from these sublethal impacts would take place within 5 years.

The Live Bottom (Low Relief) Stipulation, Eastern Pinnacle Trend Stipulation, and site-specific mitigations are expected to prevent operators from placing pipelines directly upon live-bottom communities. The effect of pipeline-laying activities on the biota of these communities would be restricted to the resuspension of sediments, possibly causing obstruction of filter-feeding mechanisms of sedentary organisms and gills of fishes. Adverse impacts from resuspended sediments would be temporary, primarily sublethal in nature, and the effects would be limited to small areas. Predicted recovery to pre-impact conditions from these sublethal impacts would take place within 5 years.

Assumptions of oil-spill occurrences, spill sizes, and estimates resulting from the OCS Program are described in Chapter 4.4.1.1. Oil spills have the potential to be driven into the water column. Measurable amounts have been documented down to a 10-m depth, although modeling exercises have indicated such oil may reach a depth of 20 m. At this depth, however, the concentration of the spilled oil or dispersed oil would be at several orders of magnitude lower than the amount shown to have an effect on marine organisms (Lange, 1985; McAuliffe et al., 1975 and 1981). In the unlikely event a freighter, tanker, or other ocean going vessel related to OCS Program activities sank and proceeded to collide with the pinnacle features or associated habitat releasing its cargo, recovery capabilities from such a catastrophic scenario are unknown at this time. For the purpose of this analysis, it is projected that no surface spills, regardless of size, would have an impact on the biota of live/hard bottoms, largely because the tops of the features crest at depths greater than 20 m. Surface oil spills are therefore not expected to impact the hard-bottom communities.

Subsurface pipeline oil spills are not expected to cause damage to live/hard-bottom biota because the oil would initially adhere to the sediments surrounding the buried pipeline until the sediment reached its maximum capacity to retain the oil before the oil rapidly rises (typically 100 m/hr in shallow water) (Guinasso, personal communication, 1997) in discrete droplets toward the sea surface. Oil-spill occurrence for the OCS Program is presented in Chapter 4.1.3.4. Since the lease stipulations and site-specific mitigations would prevent the installation of pipelines in the immediate vicinity of live/hard-bottom areas, there is little probability that a subsurface oil spill will impact live/hard bottoms. Should a pipeline spill occur in the immediate vicinity of a live/hard bottom, impacts, including the uptake of hydrocarbons and attenuated incident light penetration, could cause partial mortality of local biota. Most of the biota, however, would likely survive and recover once the live/hard bottoms were clear of oil. The adverse impacts from subsurface oil spills on live/hard bottoms would be minor in scope, primarily sublethal in nature, and the effects would be contained within a small area. Recovery to pre-impact conditions from these sublethal impacts could take place within 5-10 years.

Blowouts have the potential to resuspend sediments and release hydrocarbons into the water column, which may affect pinnacle-trend communities. Subsurface blowouts occurring near these communities can pose a threat to the biota. The severity and proximity of such an occurrence to live/hard bottoms cannot be predicted. The continued implementation of lease stipulations and mitigations should prevent blowouts from occurring directly on or in proximity to live/hard bottoms. What can be predicted is that such blowouts would cause sediments to be released and resuspended. A severe subsurface blowout within 400 m of a live/hard bottom could result in the smothering of the biota due to sedimentation. Since much of the live/hard-bottom biota is adapted to turbid conditions, most impacts would probably be sublethal with recovery taking place within 5 years.

Should the Live Bottom (Low Relief) and Pinnacle Trend Stipulations not be implemented for the proposed actions or for future lease sales, OCS activities could have the potential to destroy part of the biological communities and damage one or several live/hard-bottom features. The most potentially damaging of these are the impacts associated with physical damages that may result from anchors, structure emplacement, and other bottom-disturbing operations. Potential impacts from oil spills larger than 1,000 bbl, blowouts, pipeline emplacement, mud and cutting discharges, and structure removals exist. The OCS Program, without the benefit of protective lease stipulations and site-specific mitigations, would probably have an adverse impact on live/hard bottoms of the EPA, particularly from anchor damage to pinnacle-trend features.

Summary and Conclusion

Non-OCS activities in the vicinity of the hard-bottom communities include recreational boating and fishing, import tankering, and natural events such as extreme weather conditions, and extreme fluctuations of environmental conditions (e.g., nutrient pulses, low dissolved oxygen levels, seawater temperature minima, and seasonal algal blooms). These activities could cause severe damage that could threaten the survival of the live/hard-bottom communities. Ships using fairways in the vicinity of live/hard bottoms anchor in the general area of live/hard bottoms on occasion, and numerous fishermen take advantage of the relatively shallow and easily accessible resources of regional live/hard bottoms. These activities could lead to several instances of severe and permanent physical damage.

Impact-producing factors resulting from routine activities of OCS oil and gas operations include physical damage, anchoring, structure emplacement and removal, pipeline emplacement, drilling discharges, discharges of produced waters, and discharges of domestic and sanitary wastes. In addition, accidental subsea oil spills or blowouts associated with OCS activities can cause damage to live bottoms. Long-term OCS activities are not expected to adversely impact the live/hard-bottom environment if these impact-producing factors are restrained by the continued implementation of protective lease stipulations and site-specific mitigations. The inclusion of the Live Bottom (Low Relief) and Eastern Pinnacle Trend Stipulations would preclude the occurrence of physical damage, the most potentially damaging of these activities. The impacts to the live/hard bottoms are judged to be infrequent because of the small number of operations in the vicinity of live/hard bottoms. The impact to the live/hard-bottom resource as a whole is expected to be slight because of the projected lack of community-wide impacts.

Impacts from blowouts, pipeline emplacement, muds and cuttings discharges, other operational discharges, and structure removals should be minimized because of the proposed Live Bottom (Low Relief) and Eastern Pinnacle Trend Stipulations, and the dilution of discharges and resuspended sediments in the area. Potential impacts from discharges will probably be further reduced by USEPA discharge regulations and permits restrictions (Chapter 4.1.1.3.4.). Potential impact from oil spills greater than 1,000 bbl would be restricted because of the depth of the features (>20 m) (if the spill occurs on the sea surface), because subsea pipeline spills are expected to rise rapidly, and because of the low prospect of pipelines being routed immediately adjacent to live/hard bottoms. The frequency of impacts to live/hard bottoms should be rare and the severity slight. Impacts from accidents involving anchor placement on live/hard bottoms could be severe in small areas (those actually crushed or subjected to abrasions).

The incremental contribution of a proposed action (as analyzed in Chapters 4.2.1.2.1, 4.3.1.2.1, and 4.4.3.2.1) to the cumulative impact is expected to be slight, with possible impacts from physical disturbance of the bottom, discharges of drilling muds and cuttings, other OCS discharges, structure removals, and oil spills. Negative impacts should be restricted by the implementation of the Live Bottom (Low Relief) and Eastern Pinnacle Trend Stipulations and site-specific stipulations, the depths of the features, and the currents in the live/hard-bottom area.

Topographic Features

The Topographic Features Stipulation is assumed to be in effect for this cumulative analysis. The continued application of this stipulation would prevent any direct adverse impacts on the biota of the topographic features potentially generated by oil and gas operations. The cumulative impact from routine oil and gas operations includes effects resulting from a proposed action (Chapters 4.2.1.2.1 and 4.3.1.2.1) as well as those resulting from past and future OCS leasing. These operations include anchoring, structure emplacement, effluent discharge, blowouts, oil spills, and structure removal. Potential non-OCS-related factors include vessel anchoring, treasure hunting activities, import tankering, heavy storms and hurricanes, the collapse of the tops of the features due to dissolution of the underlying salt structure, commercial fishing, and recreational scuba diving.

Mechanical damage, including anchoring, is considered to be a catastrophic threat to the biota of topographic features. The proposed biological stipulation prohibits oil and gas leaseholders from anchoring vessels and placing structures in the No Activity Zones; the stipulation does not affect other non-OCS activities such as anchoring, fishing, or recreational scuba diving. No data are available on the extent to which non-OCS activities may take place; however, these activities are known to occur in proximity of the topographic features. Nearly all the topographic features are found near established shipping fairways and are apparently well known fishing areas. The Flower Gardens National Marine Sanctuary along with the USCG enforces a conventional hook and line rule (one hook per line) for fishing within the boundaries of the Sanctuary, which includes Stetson Bank. Also, several of the shallower topographic features are frequently visited by scuba divers aboard recreational vessels. Anchoring at a topographic feature by a vessel involved in any of these activities could damage the biota. The degree of damage would depend on the size of the anchor and chain (Gittings and Bright, 1986). Anchor damages incurred by live bottom may necessitate more than 10 years to recover. The Flower Gardens National Marine Sanctuary has a maximum 100-ft vessel anchor designation, enforced by the Sanctuary office in Bryan, Texas as well as the USCG.

The use of explosives in treasure hunting operations is typically not a concern on topographic features with the exception of Bright Bank. The blasting of large areas of Bright Bank by treasure hunters has resulted in the loss of extensive live coral cover (Bright, 1985), and as of this report, explosives are a continued form of excavation in and around Bright Bank. The recovery from such destructive activity may take in excess of 10 years, while partial resource loss is probably irreversible. Recovery of the system to pre-interference conditions would depend on the type and extent of damage incurred by individual structures (corals, etc.) of the topographic feature, however, recovery from the direct impacts from the use of explosives is unknown.

Impacts on the topographic features could occur as a result of spills or operational discharges from import tankering. Due to dilution and the depths of the crests of the topographic features, discharges should reach topographic features in insufficient concentrations to cause impacts.

Impacts from natural occurrences such as hurricanes occasionally result in damage to the biota of the topographic features. Coral colonies can be toppled and resuspended sand can scar live coral tissue, which could result in altering the structure of the reef. The collapse of the crest of the topographic features by the dissolution of the underlying salt structure is possible, but it is unlikely and certainly beyond the ability to regulate.

Depending on the levels of fishing pressure exerted, fishing activities that occur at the topographic features may impact local fish populations (Chapters 4.2.1.10 and 4.3.1.8). The collecting activities by scuba divers on shallow topographic features may have an adverse impact on the local biota; however, there is a no collecting designation at the Flower Gardens National Marine Sanctuary. Anchoring during recreational and fishing activities, however, would be the source of the majority of severe impacts incurred by the topographic features.

Anchoring on the topographic features during oil- and gas-related operations could have even greater impacts (Bright and Rezak, 1978; Rezak et al., 1985). The continued application of the biological stipulation should preclude anchoring of pipeline barges, drilling rigs, or service vessels, and structure emplacement (pipeline, drilling rig, or platform emplacement) by oil and gas leaseholders in the No Activity Zone, thus preventing adverse impacts on benthic communities of topographic communities.

The routine discharge of drilling muds and cuttings is probably substantial under the cumulative scenario; it is assumed that several million barrels of drilling fluids and cuttings would be discharged in water depths less than 200 m. The areal extent of the topographic features relative to the area of the entire CPA and WPA is small, so the actual amounts of these discharges in the vicinity of the topographic features would be a fraction of this total. Continued application of the Topographic Features Stipulation would require lease operators to comply with measures, such as shunting that would keep discharged materials at depths below sensitive biota. The USEPA, through its new NPDES discharge permit, also enacts further mitigating measures. As noted above under the proposed actions, drilling fluids can be moderately toxic to marine organisms (the more toxic effluents are not allowed to be discharged under new NPDES permits), and their effects are restricted to areas closest to the discharge point, thus preventing contact with the biota of topographic features. Small amounts of drilling effluent may reach a bank from wells outside the No Activity Zone; however, these amounts, where measurable, would be extremely small and would be restricted to small areas and have sublethal effects on the biota. Such impacts would occur infrequently and the severity of the impacts is assumed to be disruptive or of impact to only a few elements at the regional or local scale. Therefore, no interference to the ecosystem performance would be incurred. Potential recovery of the system to pre-interference conditions would take place within 2 years.

With the inclusion of the proposed Topographic Features Stipulation, no discharges of effluents, including produced water would take place within the No Activity Zones. Discharges in areas around the No Activity Zone will be shunted to within 10 m of the seabed. This procedure, combined with the new USEPA discharge regulations and permits, should eliminate the threat of discharges reaching and affecting the biota of a topographic high. The impacts that these discharges could cause would be primarily sublethal damages that could lead to a possible disruption or impairment of a few elements at the regional or local scale, but no interference to the general ecosystem performance should occur. Potential recovery of the impacted area to pre-interference conditions would take place within 2 years.

Blowouts outside the No Activity Zones are unlikely to impact the biota of the topographic features. Predicted cumulative blowouts for the proposed actions for 40 years are in Tables 4-2 and 4-3.

Few blowouts, if any, would occur in the immediate vicinity of the topographic features. It is assumed that a resuspension of sediments or a subsurface oil spill following a blowout could reach the biota of a topographic feature. If this were to occur, the impacts would be primarily sublethal with the disruption or impairment of a few elements at the local scale, but no interference to the general system performance would occur. Potential recovery of the impacted area to pre-interference conditions would take place within 2 years.

Oil-spill occurrence and contact probabilities for the OCS Program are presented in Chapter 4.1.3.4. However, because of the water depths in which topographic features are found, no oil from surface spills would reach the biota of concern at concentrations likely to cause impacts. However a subsurface oil spill could reach the biota of a topographic feature. It is assumed such spills would initially adhere to the sediments surrounding the buried pipeline or well site until the sediment reached its maximum capacity to retain the oil before rising (typically 100 m/hr; Guinasso, personal communication, 1997) in discrete droplets toward the sea surface. Any oil remaining at depth would be swept clear by currents moving around the topographic features (Rezak et al., 1983).

If a seafloor oil spill (e.g., pipeline) were to occur, the spill would have to come into contact with a biologically sensitive feature to have an impact. The extent of damage from a spill would probably be concentrated on one sensitive area (feature), due to the broad distribution of topographic features across the Western and Central Gulf. Given the random nature of spill locations, the potential impacts of oil spills on biological resources of a topographic feature would probably be restricted to discrete locations. The currents should steer any spilled oil around the features rather than directly upon them, lessening impact severity. Furthermore, No Activity Zones established by the proposed Topographic Features Stipulation would serve to limit OCS activity within close proximity to such features thereby reducing the source of spills. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for corals and much of the other fully developed reef biota. It is anticipated that recovery for such an event would occur within a period of 2 years. In the highly unlikely event that oil from a subsurface spill could reach a coral covered area in lethal concentrations, the area so impacted would be small, but recovery of this area could take in excess of 10 years. Finally, in the unlikely event a freighter, tanker, or other ocean going vessel related to OCS Program activities or non-OCS related activities sank and collided with the topographic features or associated habitat releasing its cargo, recovery capabilities from such a catastrophic scenario are unknown at this time. In November 1999 a +60 ft recreational vessel sank at the West Flower Garden Bank and remains unrecovered. Destructive impacts from the vessel colliding with the corals and associated biota of the West bank are unknown at this time.

Many platforms will be removed from the OCS Program each year in the vicinity of topographic features (Tables 4-4, 4-5, and 4-6).

However, the proposed Topographic Features Stipulation would prevent the installation of platforms in the No Activity Zones, thus reducing the potential for impact from platform removal. The explosive removals of platforms should not impact the biota of the topographic features. Similarly, other activities that resuspend bottom sediments are unlikely to impact the topographic features

Summary and Conclusion

Activities causing mechanical disturbance represent the greatest threat to the topographic features. This would, however, be prevented by the continued application of the Topographic Features Stipulation. Potential OCS-related impacts include anchoring of vessels and structure emplacement, operational discharges (drilling muds and cuttings, and produced waters), blowouts, oil spills, and structure removal.

The proposed Topographic Features Stipulation would preclude mechanical damage caused by oil and gas leaseholders from impacting the live-bottom communities of the topographic features and would protect them from operational discharges. As such, little impact would be incurred by the biota of the topographic features. New USEPA discharge regulations and permits would further reduce discharge-related impacts (Chapters 4.2.1.3 and 4.3.1.3). Recovery from any discharge-related impacts would take place within 2 years.

Blowouts could potentially cause damage to benthic biota, however, due to the application of the proposed Topographic Features Stipulation, blowouts would not occur in the immediate vicinity of the topographic features and associated biota; therefore, there would be little impact on the features. Potential recovery from any impact would take place within 2 years.

Oil spills can cause damage to benthic organisms when the oil contacts the organisms. The proposed Topographic Features Stipulation would keep sources of OCS spills away from the immediate biota of the topographic features. In the unlikely event that oil from a subsurface spill would reach the biota of a topographic feature, the effects would be primarily sublethal for corals (in the case of the Flower Garden

Banks and Stetson Bank) and much of the other fully developed biota. It is anticipated that potential recovery for such an event would occur within a period of 2 years. In the highly unlikely event that oil from a subsurface spill reached an area containing coral cover (e.g., Flower Garden Banks and Stetson Bank) in lethal concentrations, the impacted area would be small, but its recovery could take in excess of 10 years. Finally, in the unlikely event a freighter, tanker, or other ocean going vessel related to OCS Program activities or non-OCS related activities sank and proceeded to collide with the topographic features or associated habitat releasing its cargo, recovery capabilities from such a catastrophic scenario are unknown at this time.

Non-OCS activities are thought to have the greatest potential of impacting the topographic features, particularly those that could mechanically disrupt the bottom (such as anchoring and treasure-hunting activities, as previously described). Natural events such as hurricanes or the collapse of the tops of the topographic features (through dissolution of the underlying salt structure) could cause severe impacts. The collapsing of topographic features is unlikely and would, at the most, impact a single feature. Impacts from scuba diving, fishing, ocean dumping, and discharges or spills from tankering of imported oil are likely to have little or no impact on the topographic features.

The incremental contribution of a proposed action (as analyzed in Chapters 4.2.1.2.1 and 4.3.1.2.1) to the cumulative impact is negligible because of the implementation of the Topographic Features Stipulation, which would limit mechanical impacts and operational discharges. Furthermore, there is a low probability and low risk of accidental OCS-related events such as blowouts and oil spills occurring in the immediate vicinity of a topographic feature.

4.5.2.2. Deepwater Benthic Communities

Cumulative factors considered to impact the deepwater benthic communities of the Gulf of Mexico include both oil- and gas-related and non-oil- and gas-related activities. The latter type of impacting factors includes activities such as fishing and trawling. There are essentially only two species considered important to deepwater bottom fisheries – the yellowedge grouper and tilefish. Yellowedge grouper habitat only extends to only about 275 m. Bottom longlining for tilefish could potentially result in cumulative impact to deepwater communities as their habitat in the Gulf of Mexico extends to 411 m (>400 m) (Dooley, 1978). If contact did occur, impacts from bottom longlines would be minimal. Damage resulting from bottom trawling would have a much greater impact. De Forges et al. (2000) report threats to deepwater biological communities by fishing activity off New Zealand. Species similar to the targeted species in Australia and New Zealand, the orange roughy (genus *Hoplostethus*), do occur in the Gulf of Mexico; however, they are not abundant and are smaller in size. Bottom fishing and trawling efforts in the deeper water of the CPA and WPA are currently minimal, and impacts to deepwater benthic communities are negligible.

Oil- and gas-related activities include pipeline and platform emplacement activities, anchoring, accidental seafloor blowouts, drilling discharges, and explosive structure removals. This analysis considers the effects of these factors related to the proposed actions and to future OCS sales.

Other sources of cumulative impact to deepwater benthic communities would be possible, but are considered unlikely to occur. Essentially no anchoring from non-OCS-related activities occurs at the water depths where these communities are found. Some impacts are highly unlikely yet not impossible, such as the sinking of a ship or barge resulting in collision or contaminant release directly on top of a high-density community. One potential significant source of impact would be carbon sequestration in the deep sea as recently proposed by some international groups as a technique to reduce atmospheric carbon dioxide. Boyd et al. (2000) reported the successful iron fertilization of the polar Southern Ocean resulting in a large drawdown of carbon dioxide for at least 13 days and a massive plankton bloom for 30 days. Recent papers have highlighted the potential serious consequences of large scale CO_2 sequestration. Seibel and Walsh (2001) report extensive literature on the physiology of deep-sea biota indicating that they are highly susceptible to the CO_2 and pH excursions likely to accompany deep-sea CO_2 sequestration. The impacts of even very small excursions of pH and CO_2 could have serious, even global, deep-sea ecosystem impacts. Substantial additional research is needed before any large-scale actions would take place.

The greatest potential for adverse impacts to occur to the deepwater benthic communities, both chemosynthetic and nonchemosynthetic, would come from those OCS-related, bottom-disturbing activities associated with pipeline and platform emplacement (including templates and subsea completions), associated anchoring activities, discharges of muds and cuttings, and seafloor blowout accidents. The potential impacts to deepwater benthic communities from these activities are discussed in detail in Chapters 4.2.1.2.2 for the CPA and 4.3.1.2.2 for the WPA. The potential impacts from seafloor blowout accidents are discussed in Chapter 4.4.3.2.2.

As exploration and development continue on the Federal OCS, activities have moved into the deeper water areas of the Gulf of Mexico. With this trend comes the certainty that increased development will occur on discoveries throughout the entire depth range of the CPA and WPA; these activities will be accompanied by impacts to the deepwater benthos from bottom disturbances and disruption of the seafloor from associated activities. The extent of these disturbances will be determined by the intensity of development in these deepwater regions, the types of structures and mooring systems used, and the effective application of the avoidance criteria required under NTL 2000-G20. Activity levels for the cumulative scenario in the CPA and WPA are shown in Tables 4-6 and 4-5, respectively. Limited activity in the EPA is projected (Table 4-7). For the CPA deepwater offshore Subareas C200-800, C800-1600, C1600-2400 and C>2400, an estimated 4,140-5,838 exploration and delineation wells and 2,307-3,207 development wells are projected to be drilled, and 219-312 production structures are projected to be installed through the years 2003-2042. In the same water depths 53-71 blowout accidents are projected (Table 4-6). For the WPA deepwater offshore Subareas W200-800, W800-1600, W1600-2400 and W>2400, an estimated 1,030-1,671 exploration and delineation wells and 1,959-2,034 development wells are projected to be drilled, and 99-145 production structures are projected to be installed through the years 2003-2042For these same water depths 21-33 blowout accidents are projected.

Routine discharges of drilling muds and cuttings have been documented to reach the seafloor in water depths greater than 400 m (discussed in Chapters 4.2.1.2.2 and 4.3.1.2.2), but these discharges are distributed across wider areas and in thinner accumulations than they would be in shallower water depths. Potential impacts could result from accumulations of muds and cuttings resulting from consistent hydrographic conditions and drilling of multiple wells from the same location causing concentrations of material in a single direction or "splay." It is not expected that detectable levels of muds and cuttings discharges from separate developments or from adjacent lease blocks would act as a cumulative impact to deepwater benthic communities due their physical separation and great water depths.

An MMS-funded study, awarded on June 30, 2000, and entitled *Effects of Oil and Gas Exploration and Development at Selected Continental Slope Sites in the Gulf of Mexico*, will further refine the effectiveness of the new avoidance criteria. An additional study, *Improving the Predictive Capability of 3-D Seismic Surface Amplitude Data for Identifying Chemosynthetic Community Sites*, has also recently begun and is intended to groundtruth the interpretation of geophysical 3-D seismic surface anomaly data and the relationship to expected or potential community sites. The results of these studies will be used to refine the existing biological review processes for exploratory or development plans.

The majority of deepwater chemosynthetic communities are of low density and are widespread throughout the deepwater areas of the Gulf. Low-density communities may occasionally sustain minor impacts from discharges of drill muds and cuttings or resuspended sediments. These impacts are most likely to be sublethal in nature and would be limited in areal extent. The frequency of such impact is expected to be low. Physical disturbance to a small area would not result in a major impact to the ecosystem. The consequences of these impacts to these widely distributed low-density communities are considered to be minor with no change to ecological relationships with the surrounding benthos.

High-density, Bush Hill-type communities are widely distributed but few in number and limited in size. They have a high standing biomass and productivity. High-density chemosynthetic communities would be largely protected by NTL 2000-G20, which serves to prevent impacts by requiring avoidance of potential chemosynthetic communities identified by association with geophysical characteristics or by requiring photodocumentation to establish the presence or absence of chemosynthetic communities prior to approval of the structure or anchor placements. Current implementation of these avoidance criteria and understanding of potential impacts indicate that high-density communities should be protected from burial by pre-riser discharges of muds and cuttings at the bottom and burial by muds and cuttings discharges from the surface.

Small impacts are expected to occur infrequently, but the impacts from bottom-disturbing activities, if they occur, could be quite severe to the immediate area affected. If it occurred, the disturbance of a Bush Hill-type environment could lead to the destruction of a community from which recovery would occur only over long intervals (200+ years for a mature tube-worm colony and 25-50 years for a mature mussel community) or would not occur at all. The severity of such an impact is such that there may be incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

In cases where high-density communities are subjected to greatly dispersed discharges or resuspended sediments, the impacts are most likely to be sublethal in nature and limited in areal extent. The impacts to ecological function of high-density communities would be minor with recovery occurring within 2 years; however, minor impacts to ecological relationships with the surrounding benthos would also be likely.

Because of the great water depths, treated sanitary wastes and produced waters are not expected to have adverse impacts to any deepwater benthic communities. These effluents would undergo a great deal of dilution and dispersion before reaching the bottom, if ever.

A blowout at the seafloor could resuspend large quantities of bottom sediments and even create a large crater, destroying any organisms in the area. Structure removals and other bottom-disturbing activities could resuspend bottom sediments, but not at magnitudes as great as blowout events. The distance of separation provided by the adherence of NTL 2000-G20 would protect both chemosynthetic and non-chemosynthetic communities from the direct effects of deep-water blowouts.

Oil and chemical spills (potentially from non-OCS related activities) are not considered to be a potential source of measurable impacts on chemosynthetic communities because of the water depth. Oil spills from the surface would tend not to sink. Oil discharges at depth or on the bottom would tend to rise some in the water column and similarly not impact the benthos. There is also reason to expect that chemosynthetic animals are resistant to at least low concentrations of dissolved hydrocarbons in the water, as communities are typically found growing in oil saturated sediments and in the immediate vicinity of active oil and gas seeps.

Deepwater coral and other hard-bottom communities not associated with chemosynthetic communities are also expected to be protected by general adherence to NTL 2000-G20 and the shallow hazards NTL 98-12 due to the avoidance of areas represented as hard bottom on surface anomaly maps derived from 3-D seismic records. Biological reviews are performed on all activity plans (exploration and production) which includes analysis of maps and avoidance of hard bottom areas that are one of several important indicators for the potential presence of chemosynthetic communities.

Summary and Conclusion

Impacts to deepwater communities in the Gulf of Mexico from sources other than OCS activities are considered negligible. The most serious impact-producing factor threatening chemosynthetic communities is physical disturbance of the seafloor, which would destroy the organisms of these communities. Such disturbance would most likely come from those OCS-related activities associated with pipelaying, anchoring, structure emplacement, and seafloor blowouts. Drilling discharges and resuspended sediments have a potential to cause minor, mostly sublethal impacts to chemosynthetic communities, but substantial accumulations could result in more serious impacts. Seafloor disturbance is considered to be a threat only to the high-density (Bush Hill-type) communities; the widely distributed low-density communities would not be at risk. The provisions of NTL 2000-G20 require surveys and avoidance prior to drilling and will greatly reduce the risk. New studies are currently refining the information and confirming the effectiveness of these provisions. Activities unrelated to the OCS Program include fishing and trawling. Because of the water depths in these areas and the low density of potentially commercially valuable fishery species, these activities are not expected to impact deepwater benthic comminutes.

The activities considered under the cumulative scenario are expected to cause little damage to the ecological function or biological productivity of the widespread, low-density chemosynthetic communities. The rarer, widely scattered, high-density, Bush Hill-type chemosynthetic communities could experience minor impacts from drilling discharges or resuspended sediments, with recovery expected within several years. If physical disturbance (such as anchor damage) or extensive burial by muds and cuttings were to occur to high-density, Bush Hill-type communities, impacts could be severe, with recovery time as long as 200 years for mature tube-worm communities. There is evidence that substantial impacts on these communities would permanently prevent reestablishment. The severity of such an impact is such that there would be incremental losses of productivity, reproduction, community relationships, overall ecological functions of the community, and incremental damage to ecological relationships with the surrounding benthos.

The cumulative impacts on nonchemosynthetic benthic communities are expected to cause little damage to the ecological function or biological productivity of the expected typical communities existing on sand/silt/clay bottoms of the deep Gulf of Mexico. Large motile animals would tend to move, and recolonization from populations from neighboring substrates would be expected in any areas impacted by burial.

The incremental contribution of the proposed actions (as analyzed in Chapters 4.2.1.2.2, 4.3.1.2.2, and 4.4.3.2.2) to the cumulative impact is expected to be slight, and to result from the effects of the possible impacts caused by physical disturbance of the seafloor and minor impacts from sediment resuspension. Adverse impacts will be limited but not completely eliminated by adherence to NTL 2000-G20.

4.5.3. Impacts to Water Quality

Cumulative impacts to water quality will occur from the proposed actions, ongoing oil and gas activities in the OCS and State waters, and all other sources that affect water quality, both natural and anthropogenic. Non-OCS sources include industrial, recreational, agricultural, and natural activities as well as oil and gas activities in state waters. An overview of the present status of water quality in the coastal and marine waters of the potentially impacted area is given in Chapter 3.1.2. The types of impacts and impacts from the proposed actions were discussed in Chapters 4.1.1.3.4, 4.2.1.3, and 4.3.1.3.

The OCS-related activities that can impact water quality include drilling wells, installation/removal of platforms, laying pipelines, service vessel operations, and supporting infrastructure discharges. A proposed action in the CPA is projected to result in 28-49 production structures. A proposed action in the WPA is projected to result in 11-15 structures. As a result of the proposed lease sales, four in the WPA and five in the CPA, a projected 184-305 structures will be added to the Gulf. A total of 2,987 to 3,999 structures may be added from the Gulfwide OCS Program between 2003 and 2042. At the same time, structures are being removed. According to the MMS database, an average of 109 structures per year were removed between 1996 and 2000. An estimated 6,303 to 7,296 structures will be removed Gulfwide between 2003 and 2042; most removal being in water depths less than 60 m (i.e., on the continental shelf). Presently, approximately 4,000 structures exist offshore. As more structures are removed than installed over time, the impacts from discharges to water quality will decrease over the next forty years. Routine oil and gas activities potentially degrade water quality through the addition of hydrocarbons, trace metals, and suspended sediment. Accidental spills of chemicals or oil will also impair water quality temporarily.

4.5.3.1. Coastal Waters

The water quality of coastal environments will be affected by cumulative input of hydrocarbons and trace metals from activities that support oil and gas extraction. These activities include bilge water from service vessels and point and non-point source discharges from supporting infrastructure. Discharges from service vessels are regulated by USCG to minimize cumulative impacts. The USEPA regulates point-source discharges. Only non-point-source discharges are not regulated and data do not exist to evaluate the magnitude of this impact. If regulations are followed, it is not expected that additional oil and gas activities will adversely impact the overall water quality of the region.

Dredging and channel erosion can add to the suspended load of local waterways. Support vessels as well as other activities such as commercial fishing and shipping use the waterways. Accurate information concerning the direct impacts from OCS activities is not available to evaluate the degradation of water quality in the waterways.

Accidental releases of chemicals or oil would degrade water quality during the spill and after until the spill is either cleaned up or natural processes disperse the spill. The effect on coastal water quality from spills estimated to occur from a proposed action (a 4,600-bbl offshore spill projected to reach coastal waters and a 3,000-bbl spill in coastal waters) are expected to be minimal relative to the cumulative effects from hydrocarbon inputs from other sources such as river outflow, industrial discharges, and bilge water releases as discussed in the National Research Council's report *Oil in the Sea* (NRC, 1985). The cumulative impacts to coastal water quality would not be changed over the long term as a result of the proposed actions.

Summary and Conclusion

Water quality in coastal waters will be impacted by supply vessel usage and infrastructure discharges. The impacts to coastal water quality from the proposed actions is not expected to significantly add to the degradation of coastal waters as long as all regulations are followed.

4.5.3.2. Marine Waters

Water quality in marine waters will be impacted by the discharges from drilling and production activities. Sources not related to oil and gas activities that can impact marine water quality include bilge water discharges from large ships and tankers; pollutants from coastal waters that are transported away from shore, which includes runoff, river input, sewerage discharges, and industrial discharges; and natural seepage of oil and trace metals.

Drilling activities add drilling mud and cuttings to the environment. From the MMS database, an average of 1,186 wells per year were spudded from 1996 to 2000; this rate is expected to decrease. A projected 289-599 wells will be drilled in support of a proposed action in the CPA. A projected 134-281 wells will be drilled in support of a proposed action in the WPA. A projected 1,981 to 4,119 wells will be drilled over the next 40 years as a result of the 2003-2007 proposed actions. The total OCS Program is projected to result in the drilling of 26,119 to 32,385 exploratory and development wells Gulfwide between 2003 and 2042. The impacts from drilling were discussed in Chapters 4.2.1.3 and 4.3.1.3. Studies thus far indicate that as long as discharge regulations are followed, impacts to the marine environment from drilling activities are not significant.

The NRC report (1985) on oil in the sea determined that bilge water input of oil was much greater than the input of oil from oil and gas activities. Using an estimate of 10 MMbbl/yr of water produced on the OCS (Table 4-10) and an average of 29 mg/l of hydrocarbon in the water, roughly 1,300 bbl of oil are added per year to the OCS from produced water. This amount of oil is very small relative to the estimates from natural seeps (Chapter 3.1.2.2). Support vessels also add hydrocarbon contamination by discharge of bilge water, however the discharged bilge water should meet USCG regulations, thus minimizing impacts.

Limited information is available on the levels of trace metals in Gulf of Mexico marine waters and the sources of trace-metal contamination. The USEPA (1993a and b) conducted detailed analyses of trace metal concentrations in discharges and used the data to establish criteria for the discharge of drilling wastes. Impacts from trace metal contamination are not expected to be significant.

Accidental spills of chemicals and oil are expected to impact water quality on a temporary basis and only close to the spill. Winds, waves, and currents should rapidly disperse any spill and reduce impacts.

Summary and Conclusion

Cumulative impacts on the water quality of the marine environment result from the addition of discharges from exploratory and production activities to a relatively pristine environment. As long as discharge criteria are met, impacts to the marine environment are not expected to be significant.

4.5.4. Impacts on Air Quality

The Gulf of Mexico has been subdivided into subareas based on water depth (0-60, 60-200, 200-800, 800-1600, 1600-2400 and 2400+) (Figure 4-1). Table 4-4 presents the numbers of exploration, delineation, and development wells; platforms installed; and service-vessel trips for the cumulative scenario in each subarea.

The types of sources and their usage does not change from the proposed actions to the cumulative scenario. The main differences between these two analyses are that each proposed action analysis considers only the emissions associated with one lease sale and the areas analyzed were restricted to a planning area. In the cumulative analysis, the cumulative emissions from existing sources, the proposed sales, and potential future sales are combined and the area analyzed is the entire Gulf of Mexico. The cumulative Gulfwide emissions for the 40-year period under consideration are estimated in Tables 4-53 and 4-54, for the CPA and WPA, respectively.

Total OCS emissions by subarea in the WPA and CPA for the cumulative scenario are presented in Table 4-55. Pollutants are distributed to subareas proportional to the projected number of production structure installations identified for those areas.

Peak-year emissions for the entire 40 years of Gulfwide activities are presented in Table 4-56. The peak-year is expected to occur between 2003 and 2010.

The peak-year emissions are calculated by combining peak-year activity total emissions for exploratory wells, development wells, and platforms over 40 years, and superimposing peak projected activity for support vessels and other emissions into that peak year. It is important to note that well drilling activities and platform peak-year emissions are not necessarily simultaneous. However, it is assumed for this analysis that total well and platform peak-year emissions combined with vessels and other emissions occur simultaneously. Use of the peak emissions shall provide the most conservative estimates of potential impacts to onshore air quality. Peak-year emissions for each subarea for the cumulative scenario are presented in Table 4-57. Pollutants are distributed to subareas proportional to the projected number of production structure installations identified for those areas.

The platforms remain the primary source of VOC emissions. The VOC emissions are best addressed as their corresponding ozone impacts, which were studied in the Gulf of Mexico Air Quality Study (GMAQS). The GMAQS indicated that OCS activities have little impact on ozone exceedance episodes in coastal nonattainment areas, including the Houston/Galveston, Port Arthur/Lake Charles, and Baton Rouge areas. Total OCS contributions to the exceedance (greater than 120 ppb) episodes studied were less than 2 ppb. In the GMAQS, the model was also run using double emissions from OCS petroleum development activities; the resulting attributable ozone concentrations, during modeling exceedance episodes, were still small, ranging 2-4 ppb. The cumulative activities under consideration will not result in a doubling of the emissions, and because they are substantially smaller than this worst-case scenario, it is logical to conclude that their impact would be substantially smaller as well (Systems Applications International et al., 1995). Additionally, 30 CFR 250.45(f)(2) requires that, if a facility would significantly impact (defined as exceeding the MMS significance level) an onshore nonattainment area, it would have to reduce its impact fully through the application of the best available control technology (BACT) and possibly through offsets as well.

Gaseous and fine particulate matter in the atmosphere can potentially degrade the atmospheric visibility. The visibility degradation is primarily due to the presence of particulates with a size range of 1-2 microns. The sources of these particulates may come from fuel burning and the chemical transformation of the atmospheric constituents. The chemical transformation of NO_2, SO_2, and VOC may produce nitrates, sulfates, and carbonaceous particles. High humidity also may contribute to the visibility impairment in the Gulf coastal areas. Visibility is considered an important resource in the Breton National Wilderness Area, a Federal Class I area, because future air emission from all sources in the area are expected to be about the same level or less. Thus, it is expected that the impact on visibility due to the presence of fine particulates would be minor.

Approximately 1-7 percent of OCS crude-oil production is projected to be offloaded from surface vessels at shore terminals. The fugitive emissions from these offloading operations are estimated maximum of 35,019 tons of VOC. This represents about 0.38 percent of the total VOC emissions in the WPA. Safeguards to ensure minimum emissions from the offloading and loading operations have been adopted by the State of Louisiana (The Marine Vapor Recovery Act, 1989: LAC: III.2108).

Recent MMS modeling runs were conducted using the Offshore and Coastal Dispersion (OCD) Model to determine potential cumulative NO_2 and SO_2 impacts on onshore areas. Three large areas were modeled. The limiting factor on the size of the area was the run time needed to process the number of sources. The areas modeled were a 150-km circle centered over Breton Island, a 100-km circle centered over the Grand Isle area, and a 150-mi circle over the Vermilion area. Receptors were set along the coastline and also a short distance inland in order to capture coastal fumigation. Circular areas were chosen to reduce edge effect. The Breton area was chosen to capture the Class I area. The other two areas were selected to best capture most of the offshore sources and to focus on the highly concentrated areas of development. The cumulative action was modeled by comparing the projected Gulfwide cumulative emissions with the emission inventory for the GMAQS. Ratios between these two sets of total emission rates were developed and applied to the GMAQS inventory; this modified inventory was then used as the database for the sources for the OCD modeling. The emissions inventory included structures in existence prior to the PSD baseline dates. Emissions from such structures do not count toward increment consumption. Only the maximum concentrations for all of the runs are reported and are compared with the federally allowable increases in emissions, as regulated by 30 CFR 250.45(g) and 40 CFR 51.166(c).

Table 4-58 lists the highest predicted contributions to onshore pollutant concentrations from activities associated with the proposed lease sales and compares them with the maximum allowable increases over a baseline concentration established under the air quality regulations. While the table show that the OCS Program by itself would result in concentration increases that are well within the maximum allowable limits (with the exception of the annual average for NO_2 and the 24-hour average for SO_2 in the Class I area), a direct comparison between the two sets of figures is not possible. This is because the actual maximum allowable increase depends on the net change in emissions from all other sources in the area, both offshore and onshore, since the date the baseline level was established. Sources that were already in place at the applicable baseline date are included in the establishment of the baseline and the corresponding concentration and do not count in the determination of the maximum allowable increment. The increment is an additional amount of deterioration of air quality allowed under the PSD program above the baseline concentration. The baseline concentration was required to be established when the first PSD application was submitted after the trigger date for the individual pollutants. For the Breton Wilderness Class I Area, this baseline concentration was not established; therefore, the actual cap on the allowable onshore concentration is not known. Another way of thinking of this is that the baseline concentrations are a set of numbers represented by X_i and the incremental or allowable increases are another set of numbers represented by Y_i; the figures obtained by adding the X_i and the Y_i would be the correct figures to compare the modeling results to.

Because of the concern that some of the Class I area increments may be consumed, MMS has been working with FWS to initiate a study of the baseline for the Breton Wilderness Area. The MMS and FWS have been working towards this proposed Breton Air Quality Study for several years now. Questions regarding the types of sources necessary for inclusion in the inventories, as well as inventory collection practices and quality control procedures, have been the primary focus of the recent discussions. The intent of this study will be to establish a baseline inventory and then to select an appropriate model to use for modeling the baseline concentration, as well as the current concentration. These two modeled concentrations can then be compared to determine the amount of increment consumed.

The MMS has instituted a program in postlease operations to evaluate all activities within a 100-km radius of the Breton Wildlife Refuge that could result in potential SO_2 and NO_2 impacts to this Class I area. The MMS is presently coordinating the review of Development Operations Coordination Documents (DOCD's) submitted by the applicants with FWS's Air Quality Division in Denver. Mitigating measures, including low sulphur diesel fuels and stricter air emissions monitoring and reporting requirements, are required for sources that are located within 100 km of the Breton Class I Area and that exceed emission levels agreed upon by the administering agencies.

For CO, a comparison of emission rates to the MMS exemption levels will be used to assess impact. The formula to compute the emission rates in tons/yr for CO are $3,400 \bullet D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. The CO exemption level is 7,072 tons/yr for a facility at the Federal/State boundary line, which is the nearest point to shore of any facility in Federal waters. Therefore, the 7,072 tons/yr figure is the most restrictive emissions threshold for any facility in the OCS. The average emission rate for a production platform is 11.84 tons/yr, but some vessels have a higher emission rate. Nonetheless, if the total CO emissions for the entire Gulf of Mexico (at the high end of the range) were taken and assigned to the current number of production platforms (about 3,000), this would still only result in an emissions rate of approximately 26 tons/yr per platform. Not all platforms are located at the Federal/State boundary; therefore, most platforms have even larger exemption levels than the one used in this example.

For CO, a comparison of emission rates to the MMS exemption levels will be used to assess impact. The formula to compute the emission rates in tons/yr for CO are $3,400 \bullet D^{2/3}$; D represents distance in statute miles from the shoreline to the source. This formula is applied to each facility. Offshore Texas, the CO exemption level is 14,819 tons/yr for a facility at the Federal/State boundary line, which is the nearest point to shore of any facility in Federal waters. The average emission rate for a production platform is 11.84 tons/yr, but some vessels have a higher emission rate. Nonetheless, if the peak CO emissions for the entire Gulf of Mexico (at the high end of the range) were taken and assigned to the current number of production platforms (1,820), this would still only result in an emissions rate of approximately 29 tons/yr. Not all platforms are located at the 3 league line; therefore, most platforms have even larger exemption levels than the one used in this example.

Suspended particulate matter is important because of its potential in degrading the visibility in national wildlife refuges or recreational parks designated as PSD Class I areas. The impact depends on emission rates, particle size, and chemical composition. Particle size used in this analysis represents the equivalent diameter, which is the diameter of a sphere, that will have the same settling velocity as the particle. Particle distribution in the atmosphere has been characterized as being largely trimodal (Godish, 1991) with two peaks located at diameters smaller than 2 μm and a third peak with a diameter larger than 2 μm. Particles with diameters of 2 μm or larger settle very close to the source (residence time of approximately ½ day; Lyons and Scott, 1990). For particles smaller than 2 μm, which do not settle fast, wind transport determines their impacts. The PM_{10}'s are emitted at a substantially smaller rate than the two pollutants modeled with OCD; hence, impacts from PM_{10} would be expected to be even smaller. The impacts for PM were taken by scaling the ration of the PM/SO_x emissions and multiplyig them by the SO_2 impacts. $PM_{2.5}$ is of primary importance in visibility degradation. A straight ratio can be employed to give an impact in the Class I area of 0.45 ug/m^3 for the annual average and 5.85 ug/m^3 for the 24-hr average. Therefore, suspended matter is estimated to have a minimal effect on the visibility of PSD Class I areas in the Central Gulf of Mexico. A straight ratio can be employed to give an impact of 0.01 ug/m^3 for the annual average and 0.002 ug/m^3 for the 24-hr average, which are below the Class II increments in the Western Gulf of Mexico.

The amount of power generation that occurs during the period 2003-2042 is very difficult to predict because it depends on many nonquantifiable factors. Therefore, different sets of assumptions result in different estimates. The envelope of predictions shows that energy consumption should increase up to the year 2010; after this, predictions show more variation but generally indicate an increase of energy consumption. Because energy production is the largest single pollutant generator, one would suspect emissions would also increase (USDOE, 1990). However, advances in control technology and use of alternative energy sources can change the correlation between energy production and emissions. The available information (USDOE, 1990) indicates that SO_x emissions from energy generation decreased 16.4 percent between 1970 and 1987. Other pollutants that showed a decrease over the 1970-1987 period are particulate matter and NO_x. Although CO and VOC increased over the same period, the overall amount of emitted pollutants decreased.

Other major contributors to the air pollutants are from mobile sources (transportation). Not including service vessels, there were about 2.5 million vessels trips in State waters in 1999 (Table 3-30). If the projected, annual number of OCS service vessels trips were added to the 1999 figure, it is estimated that the OCS Program accounts for about 10 percent of the traffic in State waters. Each proposed action would account for <1 percent.

Emissions of the criteria pollutants related to industrial activities decreased over the 1970-1987 period. The reduction in the total amount of pollutants was 51 percent (Godish, 1991). The projected increase in employment (Chapter 3.3.3.5.1) can be interpreted as an increase of industrial activities. However, if the decreasing trend of emissions holds during the next 40 years, it is reasonable to estimate that industrial emissions would not increase; at worst they would remain at present levels. Oil and gas activity in State waters is also predicted to decline, thus further reducing pollutants (Chapter 4.1.3.1.1).

Summary and Conclusion

Based on the cumulative scenario discussed in Chapter 4.1. (Table 4-4), it is assumed that OCS emissions will maintain present levels with projected decreases in future years in relation to projected declining trends in OCS activity in the Gulf of Mexico and advances in control technology. Future impacts are intrinsically related to the continuation of trends in energy consumption and technological developments in fuel and engine efficiency.

Emissions of pollutants into the atmosphere from the activities associated with the cumulative scenario are not projected to have significant effects on onshore air quality because of the prevailing atmospheric conditions, emission rates and heights, and the resulting pollutant concentrations. Onshore impacts on air quality from emissions from cumulative OCS activities are estimated to be within Class II PSD allowable increments.

The modeling results indicate that all concentrations are below the maximum allowable PSD increments except 24-hr SO_2 and annual NO_2 for the Class I area. However, potential cumulative impacts to the Breton Wilderness Class I Area are unknown due to the baseline problem and require further study; although it should be noted that impacts from a Central proposed action are well within the PSD Class I allowable increment. The incremental contribution of the proposed actions (as analyzed in Chapters 4.2.14 and 4.3.14) to the cumulative impacts are not significant nor expected to alter onshore air quality classifications.

The above conclusion only considers the impact on air quality from OCS sources. If the onshore sources are considered, there may beconsiderable adverse effects on ozone concentration and on visibility (see also Draft EIS on the proposed OCS Oil and Gas Leasing Program 2002-2007; USDOI, MMS, 2001c). Thus, the OCS contribution to the air quality problem in the coastal areas is small, but total impact from onshore and offshore emissions may be significant because of the ozone nonattainment problem in southeast Texas and Baton Rouge, Louisiana. As a result, the implementation of the 8-hr ozone standard would lead to more areas being classified as nonattainment areas.

4.5.5. Impacts on Marine Mammals

This cumulative analysis considers activities that may occur and adversely affect marine mammals in the same general area that may be affected by a proposed action. The combination of potential impacts resulting from a proposed action in addition to past, present, and future OCS activities, incidental take in fisheries, live captures and removals, anomalous mortality events, habitat alteration, and pollution may affect marine mammals (endangered, threatened, and/or protected) in the region. The major impact-producing factors relative to a proposed action are described in Chapters 4.2.1.5 and 4.3.1.5. Sections providing supportive material for the marine mammals analysis include Chapters 3.2.4 (description of marine mammals), 4.1.1.2 (exploration), 4.1.1.3 (development and production), 4.1.2.1 (coastal infrastructure), 4.4.1 and 4.4.3.5 (spills).

Information on drilling fluids and drill cuttings and produced waters that would be discharged offshore are discussed in Chapter 4.1.1.3.4. Effluents are routinely discharged into offshore waters and are regulated by USEPA NPDES permits. Cetaceans may periodically be exposed to these discharges. Direct effects to cetaceans are expected to be sublethal. Indirect effects via food sources are not expected due to dilution and dispersion of offshore operational discharges. It should be noted, however, that any pollution in the effluent could potentially poison, kill, debilitate, or stress marine mammals and adversely affect prey species and other key elements of the Gulf of Mexico ecosystem (Tucker & Associates, Inc., 1990). Operational discharges could periodically contact and/or affect marine mammals.

Helicopter traffic is assumed to occur on a regular basis. It is projected that 338,666-415,359 OCS-related helicopter trips would occur annually in the support of OCS activities in the WPA (Table 4-5). Similarly, estimates of annual OCS-related helicopter trips in the CPA are 378,718-883,333 trips (Table 4-6). The FAA (Advisory Circular 91-36C) and corporate helicopter policy state that helicopters must maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between offshore structures. In addition, guidelines and regulations promulgated by NOAA Fisheries under the authority of the Marine Mammal Protection Act include provisions specifying helicopter pilots to maintain an altitude of 1,000 ft within 300 ft (91 m) of marine mammals. It is unlikely that cetaceans would be affected by routine OCS helicopter traffic at these altitudes, provided pilots do not alter their flight patterns to more closely observe or photograph marine mammals that they see. It is also expected that 10 percent of helicopter trips would occur at altitudes below the specified minimums listed above as a result of inclement weather. Routine overflights may elicit a startle response from and disturb nearby cetaceans (depending on the activity of the animals) (Richardson et al., 1995). Occasional overflights probably have no long-term consequences on cetaceans; however, frequent overflights could have long-term consequences if they occur repeatedly and disrupt vital activities, such as feeding and breeding. The OCS-related helicopters are not the only aircraft that fly over the coastal and offshore areas. Military, private, and commercial aircraft also traverse these areas and may impact marine mammals.

It is projected that 31,359-36,923 OCS-related, service-vessel trips would occur annually in support of OCS activities in the WPA (Table 4-5). The estimated number of OCS-related, service-vessel trips occurring annually in the CPA is calculated at 272,923-281,948 trips (Table 4-6). Noise from service-vessel traffic may elicit a startle and/or avoidance reaction by cetaceans and mask their sound reception. It is expected that the extent of service-vessel traffic predicted in the cumulative scenario could affect cetaceans either by active avoidance or displacement of individuals or groups to less suitable habitat areas. (Reaction will most likely vary with species, age, sex, and psychological status; the most vulnerable might be perinatal females and nursing calves, and those animals stressed by parasitism and disease.) The presence of multiple noise sources is expected to increase masking, disrupt routine behavioral activities, and cause short-term displacement (Richardson et al., 1995). Although the proportion of a marine mammal population exposed to noise from any one source may be small, the proportion exposed to at least one noise source may be much greater (Richardson et al., 1995). The net result of any disturbance would be dependent upon the size and percentage of the population likely to be affected; ecological importance of the disturbed area; environmental and biological parameters that influence an animal's sensitivity to disturbance and stress; or the accommodation time in response to a prolonged disturbance (Geraci and St. Aubin, 1980).

It is expected that the extent of service-vessel traffic in the cumulative scenario will affect cetaceans either via avoidance behavior or displacement of individuals or groups. Smaller delphinids may approach vessels that are in transit to bow-ride. There is the possibility of short-term disruption of movement patterns and behavior, but such disruptions are unlikely to affect survival or productivity, unless they occur frequently. Long-term displacement of animals from an area is also a possibility. It is not known whether toothed whales exposed to recurring vessel disturbance will be stressed or otherwise affected in a negative but inconspicuous way. Increased vessel traffic will increase the probability of collisions between vessels and marine mammals, resulting in injury or death to some animals (Laist et al., 2001).

In addition to OCS-related vessel trips, there are numerous other vessels traversing coastal and offshore waters that could impact marine mammals. Chapter 3.3.3.6 discusses non-OCS-related oil tanker and barge activities and non-OCS-related vessel and freight traffic. A large number of commercial and recreational fishing vessels use these areas.

It is projected that 1,842-2,668 exploration and delineation wells and 4,510-5,864 development wells would be drilled in support of OCS activities in the WPA (Table 4-5). In the CPA, 7,108-8,584 exploration and delineation wells and 12,553-15,052 development wells would be drilled in support of OCS program activities (Table 4-2). Drilling activities produce sounds at intensities and frequencies that could be heard by cetaceans. It is estimated that noise from drilling activities would be relatively constant, lasting no longer than four months at each location. Sound levels generated by drilling operations are generally low frequency (Gales, 1982). Odontocetes echolocate and communicate at higher frequencies than the dominant sounds generated by drilling platforms. The bottlenose dolphin is sensitive to high-frequency sounds and is able to hear low-frequency sounds; however, where most industrial noise energy is concentrated, sensitivity appears to be poor (Richardson et al., 1995). Baleen whales appear to be sensitive to low- and moderate-frequency sounds, but as mentioned by Richardson et al. (1995), the lack of specific data on hearing abilities of baleen whales is of special concern since baleen whales apparently are more dependent on low-frequency sounds than are other marine mammals. The effects on cetaceans from structure noise are expected to be sublethal and may elicit some degree of avoidance behavior and temporary displacement; interference with ability to detect calls from conspecifics, echolocation pulses, or other important natural sounds; or might cause temporary reduction in hearing sensitivity. It is expected that drilling noise will periodically disturb and affect cetaceans in the Gulf of Mexico. Nonetheless, exploratory wells have been drilled in the Mississippi Canyon region since 1985. Marine mammal surveys performed for MMS show that this region is inhabited by sperm whales (chiefly cows and calves) (Weller et al., 2000). Tagging and photo-identification data gathered as recently as the summer of 2001 show that sperm whales continue to use the region, even though OCS activity has increased in this area since the 1980's. Since 1991, MMS has funded multiple studies and surveys of cetaceans in the northern Gulf of Mexico. The resulting information has greatly expanded our knowledge regarding the occurrence, ecology, and behavior of marine mammals in the area. The MMS will continue to work with the MMC, NOAA Fisheries, and others involved in the study and protection of marine mammals to enhance our understanding of whether or not OCS activities have caused behavioral modifications among marine mammals occupying the region.

Potential impacts to marine mammals from the detonation of explosives include mortality, injury, and physical or acoustic harassment. Injury to the lungs and intestines and/or auditory system could occur. Harassment of marine mammals as a result of the explosion-generated shock wave and acoustic signature of the detonation is also possible. Resuspension of bottom sediments, increased water turbidity, and mobilization of bottom sediments due to detonating explosives are considered to be temporary effects.

An estimated 629-783 and 3,676-4,183 structure removals are projected to occur in the WPA (Table 4-3) and CPA (Table 4-2) respectively, between 2001 and 2040. It is expected that structure removals would cause only minor, physiological response effects on cetaceans, basically because of MMS and NOAA Fisheries guidelines for explosive removals.

Seismic surveys generate a more intense noise than other nonexplosive survey methods. Baleen whales seem tolerant of low- and moderate-level noise pulses from distant seismic surveys but exhibit behavioral changes to nearby seismic activity (Richardson et al., 1995). Subtle effects on surfacing, respiration, and dive cycles have been noted (shorter surfacings, shorter dives, and fewer blows per surfacing) (Richardson et al., 1995; Richardson, 1997). Bowhead and gray whales often show strong avoidance within 6-8 km of an airgun array. Strong avoidance of seismic pulses has been reported for bowheads as far as 24 km from an approaching seismic boat (Richardson, 1997). Bowheads have also been seen within 18.5-37.0 km of ongoing seismic operations, well inside the ensonified area (Richardson, 1997). Whales exposed to noise from distant seismic ships may not be totally unaffected even if they remain in the area and continue their normal activities (Richardson et al., 1995); there seems to be a graduation in response with increasing distance and decreasing sound level, and conspicuousness of effects diminishes, meaning that reactions may not be easy to see at a glance (Richardson, 1997). One report of sperm whales in the Gulf of Mexico indicated that the whales ceased vocalizations when seismic activity in the area was occurring (Davis et al., 1995) and that sperm whales may have moved 50+ km away (Mate et al., 1994). Goold (1996) found that acoustic contacts with common dolphins dropped sharply as soon as seismic activity began. Sperm whales during the Heard Island Feasibility Test were found to cease calling during some times when seismic pulses were received from an airgun array >300 km away (Bowles et al., 1994). Swift et al. (1999) found few, if any, effects of airgun noise on sperm whales in an area of the northeast Atlantic. No obvious behavior modifications relative to the seismic activity were recorded during the majority of the small odontocete observations made during marine mammal monitoring carried out by Impact Sciences during an Exxon 3-D seismic survey offshore California in late 1995 (Arnold, 1996). There was also no observed obvious behavior modification or harassment of large whales attributable to the sound effects of the survey (Arnold, 1996). For baleen whales, in particular, it is not known (a) whether the same individuals return to areas of previous seismic exposure, (b) whether seismic work has caused local changes in distribution or migration routes, or (c) whether whales that tolerate strong seismic pulses are stressed (Richardson et al., 1995). There are no data on auditory damage in marine mammals relative to received levels of underwater noise pulses (Richardson et al., 1995). Indirect "evidence" suggests that extended or repeated exposure to seismic pulses is unlikely to cause permanent hearing damage in marine mammals given a study of damage risk criteria; the transitory nature of seismic exploration; the presumed ability of marine mammals to tolerate exposure to strong calls from themselves or other nearby mammals; and the avoidance responses that occur in at least some baleen whales when exposed to certain levels of seismic pulses (Richardson et al., 1995). Although any one seismic survey is unlikely to have long-term effects on any cetacean species or population, available information is insufficient to be confident that seismic activities, collectively, would not have some effect on the size or productivity of any marine mammal species or population. These effects would likely be nonlethal.

Oil spills and oil-spill response activities can adversely affect cetaceans, causing skin and soft tissue irritation, fouling of baleen plates, respiratory stress from inhalation of toxic fumes, food reduction or contamination, direct ingestion of oil and/or tar, and temporary displacement from preferred habitats or migration routes. Previous studies suggested that contact with oil and consumption of oil and oil-contaminated prey are unlikely to cause more than temporary, nonlethal effects on cetaceans (Geraci, 1990). However, evidence from the 1989 *Exxon Valdez* spill indicates that oil spills have the potential to cause greater chronic (sublethal oil-related injuries) and acute (spill-related deaths occurring during a spill) effects on mammals than originally suggested. Sea otters have had decreased survival rates in the years following the *Exxon Valdez* spill, and the effects of the spill on annual survival increased rather than dissipated for animals alive when the spill occurred (Monson et al., 2000). Some short-term (0-1 month) effects of oil may be (a) changes in cetacean distribution associated with avoidance of aromatic hydrocarbons and surface oil, changes in prey distribution, and human disturbance; (b) increased mortality rates from ingestion or inhalation of oil; (c) increased petroleum compounds in tissues; and (d) impaired health (e.g., immunosuppression) (Harvey and Dahlheim, 1994). Several mechanisms for long-term injury can be postulated: (a) sublethal initial exposure to oil causing pathological damage; (b) continued exposure to hydrocarbons persisting in the environment, either directly or through ingestion of contaminated prey; and (c) altered availability of prey as a result of the spill (Ballachey et al., 1994). A few long-term effects include (a) change in distribution and abundance because of reduced prey resources or increased mortality rates; (b) change in age structure because certain year-classes were impacted more by oil; (c) decreased reproductive rate; and (d) increased rate of disease or neurological problems from exposure to oil (Harvey and Dahlheim, 1994). Effects of cleanup activities are unknown, but increased human presence (e.g., vessels) could influence cetacean behavior and/or distribution, thereby stressing animals more, and subsequently increasing their vulnerability to various anthropogenic and natural sources of mortality. In the event that oiling of cetaceans should occur from spills, the effects would probably be sublethal; few proximate deaths are expected; however, long-term impacts might be more lethal to some animals.

Oil spill estimates project that there will be numerous, frequent, small spills; many, infrequent, moderately sized spills, and infrequent, large spills occurring in coastal and offshore waters between 2003-2042 (Table 4-17). The probability that a marine mammal is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of marine mammals in the northern Gulf will be exposed to residuals of oils spilled stemming from past, present, and future lease sales during their lifetimes.

A wide variety of debris is commonly observed in the Gulf. Marine debris comes from a variety of terrestrial and marine sources (Cottingham, 1988). Some material is accidentally lost during drilling and production operations. The offshore oil and gas industry was shown to contribute 13 percent of the debris found at Padre Island National Seashore (Miller et al., 1995). Both entanglement in and ingestion of debris has caused the death or serious injury of individual marine mammals. The probability of entanglement or ingestion is largely unpredictable, but it is believed to be low.

Stock structure is completely unknown for all species in the Gulf, except for the bottlenose dolphin (Waring et al., 1997). Life history parameters have not been estimated for cetacean stocks in the Gulf, except for some coastal bottlenose dolphin stocks (Odell, 1975; Urian et al., 1996). Stock definition for bottlenose dolphins is problematic; there are a variety of possible stock structures (Blaylock and Hoggard, 1994). Inshore and offshore forms of bottlenose dolphins are commonly recognized based on morphological and ecological evidence (Hersh and Duffield, 1990). Recent work has confirmed significant genetic differences between inshore and offshore bottlenose dolphins in the Gulf of Mexico (Curry et al., 1995; LeDuc and Curry, 1997). There has been speculation that the population of bottlenose dolphins along the southeastern coast of the United States is structured such that there are local, resident stocks in certain embayments and transient stocks that migrate into and out of these embayments seasonally (Scott, 1990). There is reason to believe that some genetic exchange may occur between bottlenose dolphins inhabiting coastal waters and dolphins from bays and sounds in the Gulf (Blaylock and Hoggard, 1994). Differences in bottlenose dolphin reproductive seasonality from site to site also suggest genetic-based distinctions between communities (Urian et al., 1996).

Since the inception of the Marine Mammal Protection Act (1972), over 500 bottlenose dolphins have been live-captured and removed from southeastern U.S. waters for public display and scientific research purposes (USDOC, NMFS, 1989b). The live-capture fishery is managed under the 2 percent quota rule and based on the best available information relating to the bottlenose dolphin population abundance, stock structure, and productivity in the region (Scott and Hansen, 1989). Almost half of these dolphins were caught in the Mississippi Sound area (Tucker & Associates, Inc., 1990). Captures in the past had concentrated on the female portion of the stock, which in turn could significantly lower the potential for future recruitment (Scott, 1990). Capture activities may also stress and affect the survival and productivity of animals that are chased and captured, but not removed (Young et al., 1995; Myrick, 1988). Anomalous mortality events resulted in a temporary, if not permanent, cessation of the live-capture fishery for bottlenose dolphins in the southeastern United States (USDOC, NOAA, 1996).

Several anomalous mortality events (die-offs) have been reported for cetaceans. In the Gulf of Mexico, bottlenose dolphins have been involved in several unusual mortality events since 1990. The death of 26 bottlenose dolphins in Matagorda Bay in January 1990 was attributed to cold weather (Miller, 1992). No conclusive evidence for a single or multiple causal agent(s) was provided for the other 300+ animals that were part of the 1990 die-off on the Gulf Coast (Hansen, 1992). A localized die-off of dolphins in East Matagorda Bay in 1992 was suggested to be due to agricultural run-off (trace amounts of Aldecarb were found in the water) (Worthy, personal communication, 1995). Bottlenose dolphin stocks in the northern and western coastal portion of the northern Gulf Coast may have experienced a morbillivirus epidemic in 1993 (Lipscomb et al., 1996). In 1994, 67 percent of tested samples of a die-off of bottlenose dolphins in East Texas/Louisiana revealed that morbillivirus was present (Worthy, personal communication, 1995). A period of increased stranding of bottlenose dolphins from October 1993 through April 1994 in Alabama, Mississippi, and Texas was determined to have been caused by a morbilliviral epizootic (Lipscomb et al., 1996; Taubenberger et al., 1996). A die-off of bottlenose dolphins occurred in 1995 on the west coast of Florida (Hansen, personal communication, 1997) and on the Mississippi coast in November 1996 (Rowles, personal communication, 1996). Propagation of the morbilliviral epizootic along the coast is probably determined by contact between adjacent communities and seasonal movements of transient dolphins (Duignan et al., 1995a and 1996).

Concentrations of mortality do not appear widespread, appearing to occur in localized populations. To understand the impact and long-term effects, large-scale surveys are needed to assess impacts on the offshore dolphin distribution, while localized, small-scale surveys are required to quantify pre- and post-effects of the disease (Scott and Hansen, 1989). Blaylock and Hoggard (1994) noted that bottlenose dolphins living in enclosed systems (bays) in the U.S. might be subject to increased anthropogenic mortality due to their proximity to humans. Such dolphins would also be at increased risk of being affected by catastrophic events or by chronic, cumulative exposure to anthropogenic activities or compounds.

In spring 1996, 150 manatees were involved in a die-off; brevotoxin (red tide) was determined to be the cause (Suzik, 1997). At a regional level, 20 percent of the population was involved, while at the State level, it was 6 percent (Wright, personal communication, 1996). Sixteen manatees died in November 1997 as a result of a red tide in the same region of southwestern Florida where the 1996 die-off occurred (MMC, 1998). The first well-documented, manatee mortality event associated with a red tide was in 1982 (O'Shea et al., 1991). Free-ranging manatee exposure to a morbillivirus has been reported (Duignan et al., 1995b). The authors suggested that the infection in Florida manatees is sporadic rather than enzootic (as in cetaceans); however, Florida manatees may be at risk nonetheless for disease transmission between cows and their calves, between estrus herds, and during aggregations in warm water refuges (which is also the most stressful time of year energetically for these animals). Morbillivirus could then affect manatees either directly or through immunosuppression or abortion (Duignan et al., 1995b). Papillomavirus has recently been found in Florida manatees (Bossart, personal communication, 1997).

A variety of environmental contaminants have been found in Gulf of Mexico bottlenose dolphins (e.g., Haubold et al., 1993; Davis et al., 1993; Meador et al., 1995) and manatees (O'Shea et al., 1984; Ames and van Vleet, 1996). Atlantic spotted dolphins from the Gulf have lower contaminant levels than Gulf bottlenose dolphins (Hansen, personal communication, 1997). Some marine mammals are high-order predators that may be affected by the bioaccumulation of contaminants (Reijnders, 1986a). Manatees, as herbivores, are exposed to pesticides through ingestion of aquatic vegetation containing concentrations of these compounds. The reliance of manatees on inshore habitats and their attraction to industrial and municipal outfalls has the potential to expose them to relatively high levels of contaminants (USDOI, FWS, 2001). Contaminants, siltation, and modified deliveries of freshwater to the estuary can indirectly impact manatees by causing a decline in submerged vegetation on which manatees depend (USDOI, FWS, 2001). Manatees do not appear to accumulate large quantities of chlorinated pesticides (O'Shea et al., 1984; Ames and van Vleet, 1996). Manatees, as herbivores, occupy a lower position in the food chain than most other marine mammals. Most marine mammal species have large stores of fat, acting both as insulation and as an energy reserve. Lipophilic contaminants can accumulate in this tissue and may be released at high concentrations when the energy reserves are mobilized (UNEP, 1991).

Recently, significant accumulation of butyltin compounds (tributyltin is an antifouling agent to prevent attachment of barnacles on boat hulls) has been implicated for immune suppression and consequent disease outbreak (Kannan et al., 1997). High butyltin concentrations in liver and kidney were found in bottlenose dolphins stranded along the Atlantic and Gulf Coasts of Florida (Kannan et al., 1997). Butyltin concentrations in the livers of spotted dolphin and pygmy sperm whale were found to be 3-4 times lower than in bottlenose dolphins; it was suggested that since these are offshore species, the exposure to butyltins is expected to be minimal (Kannan et al., 1997). Butyltins tend to magnify less in cetaceans as compared to organochlorines, which exert chronic toxic effects in marine mammals. Laboratory studies demonstrate that butyltin compounds are potent inhibitors of energy production in cells, followed by lymphocyte depletion and decreased phagocytic activity resulting in immunotoxicity.

Kannan et al. (1997) suggested that butyltin compounds in addition to PCB's have contributed to the immune suppression in bottlenose dolphins.

Insufficient information is available to determine how, or at what levels and in what combinations, environmental contaminants may affect marine mammals (MMC, 1999). There is growing evidence that high contaminant burdens are associated with several physiological abnormalities, including skeletal deformations, developmental effects, reproductive and immunological disorders, and hormonal alterations (e.g., Reijnders, 1986b; Addison, 1989; Brouwer et al., 1989; Colborn et al., 1993; De Swart et al., 1994; Reijnders, 1994; Lahvis et al., 1995; Smolen and Colborn, 1995). It is possible that anthropogenic chemical contaminants initially cause immunosuppression, rendering dolphins susceptible to opportunistic bacterial, viral, and parasitic infection (De Swart et al., 1995). Studies indicate an inverse relationship between hydrocarbon contaminant levels and certain bacterial and viral antigen titers in *Tursiops* from Matagorda Bay (in Waring et al., 1997). Contaminant loads were also associated with decreased levels of testosterone (Rowles, personal communication, 1996). Debilitating viruses such as morbillivirus may result in further immunosuppression and death. A study by Ross et al. (1996) indicated that present levels of PCB's in the aquatic food chain are immunotoxic to mammals. It should also be noted that emaciated animals that have mobilized their lipid stores (which accumulate high concentrations of toxic chemicals) may be more susceptible to toxic effects as a result of remobilization of the pollutants. Several Mediterranean striped dolphins that died during a morbillivirus epizootic, and had high levels of PCB's, were found to have luteinized ovarian cysts (Munson et al., 1998). Such cysts may impede population recovery from the epidemic if similar cysts occurred on surviving dolphins (Munson et al., 1998).

Air pollution is also a health factor for cetaceans. Anthracosis has been identified in the lungs of a sample of stranded dolphins in the Sarasota Bay area, but the implications of this finding are not yet clear (Rawson et al., 1991). Participants in workshops convened by MMS in 1989 and 1999 recommended that levels of environmental contaminants and natural biotoxins should be determined and monitored in representative marine mammals that occur in the northern Gulf of Mexico (e.g., Tucker & Associates, Inc., 1990). Collectively, the National Marine Mammal Tissue Bank, the quality assurance and contaminant monitoring programs, and the regional marine mammal stranding networks constitute NOAA Fisheries' marine mammal health and stranding response program.

Commercial fisheries accidentally entangle and drown or injure marine mammals during fishing operations or by lost and discarded fishing gear; they may also compete with marine mammals for the same fishery resources (e.g., Northridge and Hofman, 1999). There is little information on cetacean/fishery interactions in Gulf of Mexico waters. Bottlenose dolphins have become entangled in recreational and commercial fishing gear. Bottlenose dolphins are often seen feeding in association with shrimp fishery operations (e.g., Fertl, 1994; Fertl and Leatherwood, 1997). Dolphins in coastal and neritic waters have been killed in shrimp trawls, as well as in experimental trawling for butterfish (Burn and Scott, 1988). Although the catch rate may be low, fisheries such as the shrimp trawl fishery with large fleets may be having significant impacts on dolphins. Marine mammals may be caught and killed occasionally in the menhaden purse seine fishery (Tucker & Associates, Inc., 1990). Dolphins have been stranded on the Gulf Coast with evidence of gillnet entanglement (e.g., Burn and Scott, 1988). There are several pelagic fisheries that may potentially take dolphins during their operations. From 1957 to 1982, the Japanese fished for tuna with longlines in the Gulf of Mexico (Russell, 1993, in Jefferson, 1995). There is no information on incidental catch of cetaceans in this fishery, but cetaceans have been taken on longlines off the U.S. east coast (Burn and Scott, 1988). The most likely major pelagic fishery in the Gulf to incidentally take dolphins is the domestic tuna/swordfish longline fishery started in the offshore Gulf of Mexico in the early 1970's, and it continues today (Russell, 1993, in Jefferson, 1995). There is no marine mammal observer program for this fishery, although there are anecdotal reports of pilot whales and possibly Risso's dolphins taking fish off the longlines.

The level of take in Gulf fisheries may be small (e.g., Reynolds, 1985; Burn and Scott, 1988), but as iterated by Tucker & Associates, Inc. (1990), the effects could be causing, or contributing to, significant population declines if the affected populations also are subject to other human-produced impacts. Information continues to be insufficient to assess the nature and extent of incidental take, its impact on affected species and populations, or how it might be reduced or avoided. In addition, shooting of bottlenose dolphins occurs infrequently. A minke whale that stranded in the Florida Keys was found to have several bullets in it (USDOC, NOAA, 1997b). These few cases may be simple vandalism or may be fisheries-related (Burn and Scott, 1988) (in response to real or perceived damage to gear and/or catch). Although the extent of incidental take and death during "ghost" fishing is largely undocumented, it has been noted as an activity of concern by NOAA Fisheries and MMC. Fishermen have been reported to shoot at dolphins to scare them away from their gear (e.g., Reynolds, 1985; Fertl, 1994; Fertl and Leatherwood, 1997). It is expected that commercial fishing equipment will periodically contact and affect cetaceans in the Gulf of Mexico.

Adequate conservation strategies for marine mammals must take into account the natural history and ecology of important prey species; this is something that is currently under emphasized in research and conservation efforts (Heithaus and Connor, 1995; Trites et al., 1997). For example, Trites et al. (1997) suggested that fisheries may indirectly compete with marine mammals by reducing the amount of primary production accessible to marine mammals, thereby negatively affecting marine mammal numbers.

Habitat loss and degradation is now acknowledged to be a significant threat to cetacean populations. The impact of coastal development on Gulf of Mexico cetaceans has not been adequately investigated. It has been suggested that apparent declines in bottlenose dolphin abundance in some areas can be attributed to pollution and heavy boat traffic (e.g., Odell, 1976). Bottlenose dolphins in Sarasota Bay appear to use less-altered areas more frequently, but specific effects are uncertain (Wells, 1992). On the other hand, habitat alteration in the form of artificial passes in southern Texas may have opened up new habitat for bottlenose dolphins (Leatherwood and Reeves, 1983). Habitat alteration has the potential to disrupt the social behavior, food supply, and health of cetaceans that occur in the Gulf of Mexico. Such activities may stress animals and cause them to avoid traditional feeding and breeding areas, or migratory routes. The most serious threat to cetacean populations from habitat destruction may ultimately prove to be its impact on the lower trophic levels of their food chains (Kemp, 1996). Intensive coastal development is degrading important manatee habitat and poses perhaps the greatest long-term threat to the Florida manatee (USDOI, FWS, 2001).

Coastal bottlenose dolphin populations in the southeastern U.S. have the potential to be impacted by commercial dolphin-watching trips that feed dolphins as part of their tours. Feeding wild dolphins is likely to disrupt normal behavior, particularly feeding and migration patterns (USDOC, NMFS, 1994b). This activity could make dolphins dependent upon unnatural food sources and more vulnerable to being hit by boats, malicious shooting, and accidental or deliberate food poisoning (USDOC, NMFS, 1994b). Although the Marine Mammal Protection Act classifies such activities as "harassment," feeding continues due to lack of enforcement. In May 1997, NMFS embarked upon a media and education campaign in Florida (including Panama City Beach, which is an area of particular concern) to increase public awareness about the dangers of swimming with, feeding, and harassing wild dolphins (Seideman, 1997; USDOC, NMFS, 1998c). NOAA filed charges in Summer 1998 against a group of people in the Florida panhandle for harassing or attempting to harass dolphins by feeding or attempting to feed them (Spradlin, personal communication, 1998). Migrating baleen whales may be affected by whale-watching activities on the East Coast, as well as in the Caribbean (Hoyt, 1995). Impacts of whale watching on cetaceans may be measured in a short time-scale (i.e., startle reaction) or as a long-term effect on reproduction or survivability (IFAW, 1995). There is little evidence to show that short-term impacts have any relation to possible long-term impacts on cetacean individuals, groups, or populations (IFAW, 1995). There are six manatee sanctuaries in Kings Bay; human access to these areas is prohibited to provide manatees a place to avoid disturbance by divers and boats. A number of cases of harassment of manatees by divers have involved waters around Three Sisters Spring, located in a canal off Kings Bay (Seideman, 1997; MMC, 1998). Manatees were forced away from the spring by divers approaching to touch them or to pose for photographs with them (MMC, 1998).

It is possible that harassment in any form may cause a stress response (Young et al., 1995). Marine mammals can exhibit some of the same stress symptoms as found in terrestrial mammals (Thomson and Geraci, 1986). Stress often is associated with release of adrenocroticotrophic hormones or cortisol. Thomas et al. (1990) examined the effect of playbacks of drilling platform noise on captive belugas. They found no behavioral (swim patterns, social group interactions, and dive/respiration rates) or physiological (blood catecholamines) indications of stress from drilling noises. It is important to recognize that disturbance from vessel traffic, noise from ships, aircraft, and drilling rigs and/or exposure to sublethal levels of biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal. Chronic stress may cause damage to the heart muscle and vasculature (Curry and Edwards, 1998).

Stressed animals may also fail to reproduce at normal rates or exhibit significantly high fetotoxicity and malformations in the young, as evidenced in some small laboratory mammals. For example, a heavily fished population of spotted dolphins in the eastern tropical Pacific was found to have a substantially lower pregnancy rate and a significantly higher (i.e., delayed) age at sexual maturity than nearby, sporadically fished, spotted dolphins; chronic stress is one possibility (Myrick and Perkins, 1995). Marine mammals may stay in an area despite disturbance (such as noise) if no alternative, suitable habitat areas are available to the animals.

The incremental contribution of impacts stemming from a proposed action are expected to be primarily sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris). However, cumulative impacts of the activities discussed in this section will likely yield deleterious effects to cetaceans occurring in the Gulf of Mexico. Biological significance of any mortality would depend, in part, on the size and reproductive rates of the affected stocks, as well as the number, age, and sex of animals affected.

Summary and Conclusion

Activities considered under the cumulative scenario could affect protected cetaceans and sirenians. These marine mammals could be impacted by the degradation of water quality resulting from operational discharges, vessel traffic, noise generated by platforms, drillships, helicopters and vessels, seismic surveys, explosive structure removals, oil spills, oil-spill response activities, loss of debris from service vessels and OCS structures, commercial fishing, capture and removal, and pathogens. The cumulative impact on marine mammals is expected to result in a number of chronic and sporadic sublethal effects (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) that may stress and/or weaken individuals of a local group or population and predispose them to infection from natural or anthropogenic sources. Few deaths are expected from oil spills, chance collisions with OCS service vessels, ingestion of plastic material, commercial fishing, and pathogens. Oil spills of any size are estimated to be recurring events that would periodically contact marine mammals. Deaths as a result of structure removals are not expected to occur due to mitigation measures (e.g., NOAA Fisheries Observer Program). Disturbance (noise from vessel traffic and drilling operations, etc.) and/or exposure to sublethal levels of toxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal. The net result of any disturbance would be dependent upon the size and percentage of the population likely to be affected; ecological importance of the disturbed area; environmental and biological parameters that influence an animal’s sensitivity to disturbance and stress; or the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). Collisions between cetaceans and ships, though expected to be rare events, could cause serious injury or mortality.

Effects of the incremental contribution of a proposed action combined with non-OCS activities may be deleterious to cetaceans occurring in the Gulf of Mexico. Biological significance of any mortality would depend, in part, on the size and reproductive rates of the affected stocks, as well as the number, age, and size of animals affected.

4.5.6. Impacts on Sea Turtles

This cumulative analysis considers the effects of impact-producing factors related to a proposed action plus those related to other OCS activities; State oil and gas activity; crude oil imports by tanker; and other commercial, military, recreational, offshore and coastal activities that may occur and adversely affect populations of sea turtles in the same general area of the proposed actions in the WPA and CPA. The combination of potential impacts 8resulting from a proposed action in addition to prior and future OCS sales, State oil and gas activity, dredge-and-fill operations, water quality degradation, natural catastrophes, pollution, recreational and commercial fishing, dredges, vessel traffic, beach nourishment, beach lighting, power plant entrainment, and human consumption affect the loggerhead, Kemp’s ridley, hawksbill, green, and leatherback turtles found in the Gulf of Mexico. Major impact-producing factors related to the proposed actions that may occur are reviewed in detail in Chapters 4.2.1.6 and 4.3.1.6. Sections providing supportive material for the sea turtle analysis include Chapters 3.2 (physical environment), 3.2.5 (description of sea turtles), 4.1.1 (offshore impact-producing factors), 4.1.2 (coastal impact-producing factors), 4.1.3 (other activities) and 4.4.3 (environmental impacts of accidental events).

Effluents are routinely discharged into offshore waters and are regulated by USEPA NPDES permits. Most operational discharges are diluted and dispersed when released in offshore areas and, given the current USEPA permit restrictions on discharges, are considered to have little effect (API, 1989; Kennicutt, 1995). Any potential that might exist for impact from drilling fluids would seem to be indirect, either by impact on prey items or possibly through ingestion via the food chain (API, 1989). Contaminants in drilling mud discharge may biomagnify and bioaccumulate in the food web, which may kill or debilitate important prey species of sea turtles or species lower in the marine food web (for further information on bioaccumulation, see Chapter 4.1.1.3.4). This may ultimately reduce reproductive fitness in turtles, an impact that the diminished population(s) cannot tolerate.

Structure installation and removal, pipeline placement, dredging, and water quality degradation may adversely affect sea turtle foraging habitat through destruction of seagrass beds and live-bottom communities used by sea turtles (Gibson and Smith, 1999). At the same time, it should be noted that structure installation creates habitat for subadult and adult sea turtles, which may enhance the recovery of some turtle populations. Potential impacts on these habitats caused by the OCS Program in the cumulative activity area are discussed in detail in Chapters 4.5.1 and 4.5.2.

Noise from service-vessel and helicopter traffic may cause a startle reaction from sea turtles and produce temporary stress (NRC, 1990). It is assumed that helicopter traffic would occur on a regular basis. It is projected that 338,666-415,359 OCS-related helicopter trips would occur annually in the support of OCS activities in the WPA (Table 4-5). Similarly, estimates of annual OCS-related helicopter trips in the CPA are 378,718-883,333 trips (Table 4-6). The FAA's Advisory Circular 91-36C encourages pilots to maintain greater than minimum altitudes near noise-sensitive areas. Corporate helicopter policy states that helicopters should maintain a minimum altitude of 700 ft while in transit offshore and 500 ft while working between platforms. The OCS-related helicopters are not the only aircraft that fly over the coastal and offshore areas. Military, private, and commercial air traffic also traverse these areas and have the potential to cause impacts to sea turtles. Other sound sources potentially impacting sea turtles include seismic surveys. Seismic surveys use airguns to generate sound pulses; these are a more intense sound than other nonexplosive sound sources. Data are limited but show that reactions of turtles to seismic pulses deserve detailed study. Seismic activities would be considered primarily annoyance and probably cause a short-term behavioral response.

The potential impacts of anthropogenic sounds on sea turtles include physical auditory effects (temporary threshold shift), behavioral disruption, long-term effects, masking, and adverse impacts on the food chain. Noise-induced stress has not been studied in sea turtles. It is expected that drilling noise will periodically disturb and affect turtles in the Gulf of Mexico. Based on the conclusions of Lenhardt et al. (1983) and O'Hara and Wilcox (1990), low-frequency sound transmissions (such as those produced by operating platforms) could cause increased surfacing and deterrence behavior from the area near the sound source.

Increased surfacing places turtles at greater risk of vessel collision. Collisions between service vessels or barges and sea turtles would likely cause fatal injuries. It is projected that 31,359-36,923 OCS-related, service-vessel trips would occur annually in support of OCS activities in the WPA (Table 4-5). The estimated number of OCS-related, service-vessel trips occurring annually in the CPA is calculated at 272,923-281,948 trips (Table 4-6). Vessel traffic in general is estimated to cause about 9 percent of all sea turtle deaths in the southeastern U.S., and this mortality would likely increase if fishing, recreational, and OCS Program vessel traffic continue to increase in the Gulf. Regions of greatest concern may be those with high concentrations of recreational boat traffic, such as the many coastal bays in the Gulf. Chapter 3.3.3.6 discusses non-OCS-related oil tanker and barge activities and non-OCS-related vessel and freight traffic. Numerous commercial and recreational fishing vessels also use these areas.

Explosive discharges such as those used for structure removals can cause capillary injury to sea turtles (Duronslet et al., 1986). Although sea turtles far from the site may suffer only disorientation, those near detonation sites would likely sustain fatal injuries. Injury to the lungs and intestines and/or auditory system could occur. Other potential impacts include physical or acoustic harassment. To minimize the likelihood of removals occurring when sea turtles may be nearby, MMS has issued guidelines for explosive platform removal to offshore operators. These guidelines include daylight-limited detonation, staggered charges, placement of charges 5 m below the seafloor, and pre- and post-detonation surveys of surrounding waters. Resuspension of bottom sediments, increased water turbidity, and mobilization of bottom sediments due to explosive detonation are considered to be temporary effects. An estimated 629-

783 and 3,676-4,183 structure removals are projected to occur in the WPA (Table 4-3) and CPA (Table 4-2) respectively, between 2001 and 2040. With existing protective measures (NOAA Fisheries Observer Program and daylight-only demolition) in place, it is expected that "take" of sea turtles during structure removals would be limited.

Sea turtles may be seriously affected by marine debris. Trash and flotsam generated by the OCS Program in the Gulf and other users of the Gulf (Miller and Echols, 1996) is transported around the Gulf and Atlantic via oceanic currents (Plotkin and Amos, 1988; Hutchinson and Simmonds, 1992). Turtles that consume or become entangled in trash or flotsam may become debilitated or die (Heneman and the Center for Environmental Education, 1988). Monofilament line is the most common debris to entangle turtles (NRC, 1990). Fishing-related debris is involved in about 68 percent of all cases of sea turtle entanglement (O'Hara and Iudicello, 1987). Floating plastics and other debris, such as petroleum residues drifting on the sea surface, accumulate in sargassum drift lines commonly inhabited by hatchling sea turtles; these materials could be toxic. In a review of worldwide sea turtle debris ingestion and entanglement, Balazs (1985) found that tar was the most common item ingested. High rates of oiling of hatchlings netted from sargassum rafts suggest that bioaccumulation may occur over their naturally long lifespan. Sea turtles, particularly leatherbacks, are attracted to floating plastic because it resembles food, such as jellyfishes. Ingestion of plastics sometimes interferes with food passage, respiration, and buoyancy and could reduce the fitness of a turtle or kill it (Carr, 1987; USDOC, NOAA, 1988; Heneman and the Center for Environmental Education, 1988; Lutz and Alfaro-Shulman, 1992). The MMS prohibits the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), prohibits the disposal of plastics at sea or in coastal waters.

Since sea turtle habitat in the Gulf includes both inshore and offshore areas, sea turtles are likely to encounter spills. Oil spill estimates project that there will be numerous, frequent, small spills; many, infrequent, moderately sized spills, and infrequent, large spills occurring in coastal and offshore waters between 2003-2042 (Table 4-17). The probability that a sea turtle is exposed to hydrocarbons resulting from a spill extends well after the oil spill has dispersed from its initial aggregated mass. Populations of sea turtles in the northern Gulf will be exposed to residuals of spilled oils. Oil spills can adversely affect sea turtles by toxic ingestion or blockage of the digestive tract, inflammatory dermatitis, ventilatory disturbance, disruption or failure of salt gland function, red blood cell disturbances, immune responses, and displacement from important habitat areas (Witham, 1978; Vargo et al., 1986; Lutz and Lutcavage, 1989; Lutcavage et al., 1995). Sea turtles may become entrapped by tar and oil slicks and rendered immobile (Witham, 1978; Plotkin and Amos, 1988). In the past, tanker washings were a major source of oil in GOM waters (Van Vleet and Pauly, 1987). Although disturbances may be temporary, turtles chronically ingesting oil may experience organ degeneration accumulate in tissues. Exposure to oil may be fatal, particularly to juvenile and hatchling sea turtles. Hatchling and juvenile turtles are particularly vulnerable to contacting or ingesting oil because currents that concentrate oil spills also form the habitat mats in which these turtles are sometimes found (Carr, 1980; Collard and Ogren, 1990; Witherington, 1994). There is also evidence that sea turtles feed in surface convergence lines, which could also prolong their contact with viscous weathered oil (Witham, 1978; Hall et al., 1983). Fritts and McGehee (1982) noted that sea turtle eggs were damaged by contact with weathered oil released from the 1979 *Ixtoc* spill. Epidermal damage in turtles is consistent with an acute, primary contact or irritant dermatitis. A break in the skin barrier could act as a portal of entry for pathogenic organisms, leading to infection, neoplastic conditions, and debilitation (Vargo et al., 1986). Captive turtles exposed to oil either reduced the amount of time spent at the surface, possibly avoiding oil, or became agitated and demonstrated short submergence levels (Lutcavage et al., 1995). Sea turtles sometimes pursue and swallow tarballs, and there is no conclusive evidence that wild turtles can detect and avoid oil (Odell and MacMurray, 1986; Vargo et al., 1986). A loggerhead turtle sighted during an aerial survey in the Gulf of Mexico surfaced repeatedly within a surface oil slick for over an hour (Lohoefener et al., 1989). Oil might have a more indirect effect on the behavior of sea turtles. Assuming olfaction is necessary to sea turtle migration, oil-fouling of a nesting area may disturb imprinting of hatchling turtles or confuse turtles during their return migration after a 6- to 8-year absence (Geraci and St. Aubin, 1985). The effect on reproductive success could therefore be significant.

When an oil spill occurs, the severity of effects and the extent of damage to sea turtles are affected by geographic location, oil type, oil dosage, impact area, oceanographic conditions, and meteorological conditions (NRC, 1985). Eggs, hatchlings, and small juveniles are particularly vulnerable upon contact (Fritts and McGehee, 1982; Lutz and Lutcavage, 1989). Potential toxic impacts to embryos will depend on the type of oil and degree of weathering, type of beach substrate, and especially upon the developmental stage of the embryo. Although many observed physiological insults are resolved in a 21-day recovery period, the impact of tissue oil intake on the long-term health and survival of sea turtles remains unknown (Lutcavage et al., 1995).

Oil-spill response activities, such as vehicular and vessel traffic in coastal areas of seagrass beds and live-bottom communities, can alter sea turtle habitat and displace sea turtles from these areas. Effects on seagrass and reef communities have been noted (reviewed by Coston-Clements and Hoss, 1983). Impacting factors include artificial lighting from night operations, booms, machine and human activity, equipment on beaches and in intertidal areas, sand removal and cleaning, and changed beach landscape and composition. Some resulting impacts from cleanup could include interrupted or deferred nesting, crushed nests, entanglement in booms, and increased mortality of hatchlings due to predation during the extended time required to reach the water (Newell, 1995; Lutcavage et al., 1997; Witherington, 1999). The strategy for cleanup operations should vary, depending on season, recognizing that disturbance to nests may be more detrimental than oil (Fritts and McGehee, 1982). As mandated by the Oil Pollution Act of 1990 (Chapter 1.3), these areas are expected to receive individual consideration during oil-spill cleanup. Required oil-spill contingency plans include special notices to minimize adverse effects from vehicular traffic during cleanup activities and to maximize protection efforts to prevent contact of these areas with spilled oil. Studies are lacking of the effects of dispersants and coagulants on sea turtles (Tucker & Associates, Inc., 1990).

Information on nesting areas for turtles in the Gulf may be found in Chapter 3.2.5.

Sea turtles may be harmed by a variety of human activities throughout their ranges, particularly because of their wide-ranging movements in coastal waters. Major activities affecting sea turtles inhabiting the Gulf include commercial fishing, hopper dredging, pollutant discharge, ingestion of or entanglement in debris, coastal boat traffic, human consumption, and contact with foreign, inshore, or processed oil (reviewed in NRC, 1990; Lutcavage et al., 1997). Demographic analyses suggest reducing human-induced mortality of juvenile, subadult, or adult life stages will significantly enhance population growth, more so than reducing human-induced mortality of eggs and hatchlings (NRC, 1990).

The chief areas utilized by Kemp's ridleys (coastal waters less than 18 m in depth) overlap with that of the shrimp fishery (Renaud, 1995). A major source of mortality for loggerhead and Kemp's ridleys is capture and drowning in shrimp trawls (Murphy and Hopkins-Murphy, 1989); 70-80 percent of turtle strandings are related to interactions with this fishery (Crowder et al., 1995). Recent analysis of loggerhead strandings in South Carolina indicates a high turtle mortality rate from the shrimp fishery through an increase in strandings, and that the use of turtle excluder devices (TED's) could greatly reduce strandings (a 44% reduction) (Crowder et al., 1995). On the other hand, Caillouet et al. (1996) found a significant positive correlation between turtle stranding rates and shrimp fishing intensity in the northwestern Gulf of Mexico. The Kemp's ridley population, due to its distribution and small numbers, is at greatest risk. In response to increased numbers of dead sea turtles that washed up along the coasts of Texas, Louisiana, Georgia, and northeast Florida in 1994-1995, and coincident with coastal shrimp trawling activity, NMFS increased enforcement efforts (relative to TED's), which decreased the number of strandings. However, deaths are believed to occur in association with some inshore shrimping operations that do not presently require TED use (Crouse, 1992). Other fisheries and fishery-related activities are important sources of mortality, but are collectively only one-tenth as important as shrimp trawling (NRC, 1990). Turtles may be accidentally caught and killed in finfish trawls, seines, gill nets, weirs, traps, longlines, and driftnets, but deaths are neither fully documented nor regulated (Hillestad et al., 1982; NRC, 1990; Witzell, 1992; Brady and Boreman, 1994). Cannon et al. (1994) reported a number of Kemp's ridleys being caught by hook and line (Cannon et al., 1994). It is possible that some Kemp's ridleys surviving capture by hook and line may suffer from ill effects of hooks lodged in the esophagus or stomach following their release. Collisions with boats may also disable or kill sea turtles. In most cases, it is not possible to determine whether the injuries resulted in death or were post-mortem. An animal with an open wound has an increased probability of predation. Of the turtles stranded in the Gulf, approximately 9 percent exhibited injuries attributed to boats (Teas and Martinez, 1992). Regions of increased concern are those with high concentrations of recreational-boat traffic, such as the coastal bays of the Gulf.

Dredge-and-fill activities occur in many of the coastal areas inhabited by sea turtles. Operations range in scope from propeller dredging (scarring) by recreational boats to large-scale navigation dredging and fill for land reclamation. Dredging operations affect turtles through accidental take and habitat degradation. Hopper dredging has caused turtle mortality in coastal areas, including Cape Canaveral Ship Channel in Florida and the King's Bay Submarine Channel in Georgia (Slay and Richardson, 1988); deaths in the Gulf of Mexico have not been estimated. Nearly all sea turtles entrained by hopper dredges are dead or dying when found, but an occasional small green turtle has been known to survive (NRC, 1990). In addition to direct take, channelization of the inshore and nearshore areas can degrade foraging and migratory habitats via spoil dumping, degraded water quality/clarity, and altered current flow.

Sea turtles frequent coastal areas such as algae and seagrass beds to seek food and shelter (Carr and Caldwell, 1956; Hendrickson, 1980). Coastal areas are also used by juvenile Kemp's ridleys in Louisiana (Ogren, 1989) and Texas (Manzella and Williams, 1992). Juvenile hawksbill, loggerhead, and green turtles are typically found in coastal Texas waters (Shaver, 1991). Submerged vegetated areas may be lost or damaged by activities altering salinity, turbidity, or natural tidal and sediment exchange. Natural catastrophes, including storms, floods, droughts, and hurricanes, can also substantially damage nesting beaches and coastal areas used by sea turtles (Agardy, 1990). Abnormally high tides and waves generated by storms may exact heavy mortality on sea turtles by washing them from the beach, inundating them with sea water, or altering the depth of sand covering them. Furthermore, excessive rainfall associated with tropical storms may reduce the viability of eggs. Turtles could be harmed in rough seas by floating debris (Milton et al., 1994). In addition, the hurricane season for the Caribbean and Western Atlantic (June 1-November 1) overlaps the sea turtle nesting season (March through November) (NRC, 1990). Nests are vulnerable to hurricanes during the incubation period as well as when hatchlings evacuate the nest. Hurricanes can cause mortality at turtle nests through immediate drowning from ocean surges, nest burial or exhumation before hatching, and after hatching as a result of radically altered beach topography. The greatest surge effect from Hurricane Andrew in 1992 was experienced at beaches closest to the "eye" of the hurricane; egg mortality was 100 percent (Milton et al., 1994). In areas farther from the "eye," the surge was lower and mortality was correspondingly decreased. Sixty-nine percent of eggs on Fisher Island in Miami, Florida did not hatch after Hurricane Andrew and appeared to have "drowned" during the storm (Milton et al., 1994). Further mortality occurred when surviving turtles suffocated in nests situated in the beach zone where sand had accreted. This subsequent mortality may be reduced if beach topography is returned to normal and beach debris removed after a hurricane (Milton et al., 1994). Species that have limited nesting ranges, such as the Kemp's ridley, would be greatly impacted if a hurricane made landfall at its nesting beach (Milton et al., 1994). Hurricane Erin in 1995 caused a 40.2 percent loss in hatchling production on the southern half of Hutchinson Island (Martin, 1996). A beach can be completely closed to nesting after a hurricane. For example, at Buck Island Reef National Monument on St. Croix, after Hurricane Hugo in 1989, 90 percent of the shoreline trees on the North Shore were blown down parallel to the water, blocking access to nesting areas (Hillis, 1990). "False crawl ratios" for hawksbill turtles doubled after the hurricane, mostly due to fallen trees and eroded root tangles blocking nesting attempts (Hillis, 1990). Other direct impacts of Hurricane Hugo on sea turtle habitats include destruction of coral reef communities important to hawksbill and green turtles. Nooks and crannies in the reef used by these turtles for resting were destroyed in some areas (Agardy, 1990). Seagrass beds, which are important foraging areas for green turtles, were widely decimated in Puerto Rico (Agardy, 1990). Indirect effects (contamination of food or poisoning of reef-building communities) on the offshore and coastal habitats of sea turtles include pollution of nearshore waters from storm-associated runoff.

Construction, vehicle traffic, beachfront erosion, and artificial lighting are activities that disturb sea turtles or their nesting beaches (Raymond, 1984; Garber, 1985). Traffic may compress nests and beach cleaning may compact or destroy nests, lowering hatching success (Coston-Clements and Hoss, 1983). Physical obstacles, such as deep tire tracks and expanded sand piles, may obstruct hatchling turtles from entering the sea or increase their stress and susceptibility to predation (Witham, 1995). Obstructions to the high water mark prevent nesting, and breakwalls are the most common and severe type of obstruction. Erosion of nesting beaches results in the loss of nesting habitat. Human interference has hastened erosion in many places. Artificial lighting from buildings, street lights, and beachfront properties may disorient hatchlings, as well as adults (Witherington and Martin, 1996). Females tend to avoid areas where beachfront lighting is most intense; turtles also abort nesting attempts more often in lighted areas.

Hatchlings are attracted to lights, and may delay their entry into the sea, thereby increasing their vulnerability to terrestrial predators. Condominiums sometimes block sunlight on nesting beaches, which could presumably affect sex ratios of hatchlings (the sex of a turtle is dependent on egg temperature) by increasing the number of males produced (discussed by Mrosovsky et al., 1995). Increased human activities, such as organized turtle watches, on nesting beaches may affect nesting activity (Fangman and Rittmaster, 1994; Johnson et al., 1996).

Sea turtles can become entrained in intake pipes for cooling water at coastal power plants (NRC, 1990). An offshore intake structure may appear as suitable for resting at to some turtles, and these turtles may be subsequently drawn into a cooling system (Witham, 1995). Feeding leatherbacks probably follow large numbers of jellyfish into the intake (Witham, 1995). Deaths result from injuries sustained in transit through the intake pipe, from drowning in the capture nets, and perhaps from causes before entrainment. Mortality from entrainment in power plants is believed to be generally low, although there has been a high number of turtle fatalities at the St. Lucie plant in southeastern Florida (NRC, 1990). Thermal effluents from power plants may cause hatchlings to become disoriented and reduce their swimming speed (O'Hara, 1980). These effluents may also degrade seagrass and reef habitats (reviewed by Coston-Clements and Hoss, 1983).

Sand mining, beach renourishment, and oil-spill cleanup operations may remove sand from the littoral zone and temporarily disturb onshore sand transport, potentially disturbing nesting activities. The main causes of permanent nesting beach loss within the Gulf of Mexico are the reduction of sediment transport, rapid rate of relative sea-level rise, coastal construction and development, and recreational use of accessible beaches near large population centers. Crain et al. (1995) reviewed the literature on sea turtles and beach nourishment and found certain problems repeatedly identified. For nesting females, characteristics induced by nourishment can cause (a) beach compaction, which thereby may decrease nesting success, alter nest-chamber geometry, and alter nest concealment; and (b) escarpments, which can block turtles from reaching nesting areas. For eggs and hatchlings, nourishment can decrease survivorship and affect development by altering beach characteristics such as sand compaction, gaseous environment, hydric environment, contaminant levels, nutrient availability, and thermal environment. Additionally, nests can be covered with excess sand if beach nourishment occurs in areas with incubating eggs.

Human consumption of turtle eggs, meat, or byproducts occurs worldwide and depletes turtle populations (Cato et al., 1978; Mack and Duplaix, 1979). Commercial harvests are no longer permitted within continental U.S. waters, and Mexico recently banned such activity (Aridjis, 1990). Since sea turtles are highly migratory species, the taking of turtles in subsistence and commercial sea turtle fisheries is still a concern.

Chronic pollution, including industrial and agricultural wastes and urban runoff, threatens sea turtles worldwide (Frazier, 1980; Hutchinson and Simmonds, 1991). Some turtle species have lifespans exceeding 50 years (Congdon, 1989; Frazer et al., 1989) and are secondary or tertiary consumers in marine environs, creating the potential for bioaccumulation of heavy metals (Hillestad et al., 1974; Stoneburner et al., 1980; Davenport et al., 1990), pesticides (Thompson et al., 1974; Clark and Krynitsky, 1980; Davenport et al., 1990), and other toxins (Lutz and Lutcavage, 1989) in their tissues. Organochlorine pollutants have been documented in eggs, juveniles, and adult turtles (Rybitski et al., 1995). Not all species accumulate residues at the same rate; loggerheads consistently have higher levels of both PCB's and DDE than green turtles, and it has been hypothesized that the variation is due to dietary differences (George, 1997). Contaminants could stress the immune system of turtles or act as cocarcinogens indirectly by disrupting neuroendocrine functions (Colborn et al., 1993). In some marine mammals, chronic pollution has been linked with immune suppression, raising a similar concern for sea turtles.

Herbst and Jacobson (1995) and George (1997) reviewed sea turtles diseases. Green turtle fibropapillomatosis (GTFP) (debilitating tumors occurring primarily in green turtles) is a growing threat to the survival of green turtle populations worldwide (Herbst, 1994). The disease was documented in the 1930's (Smith and Coates, 1938), and its incidence has increased in the last century, especially from 1985 to 1990, in turtles found in Florida, Hawaii, and Puerto Rico. This disease may cause an increased susceptibility to marine parasites and anemia, as well as impairing feeding and swimming, increased vulnerability to entanglement, disorientation, and impaired vision or blindness (Norton et al., 1990; Barrett, 1996). Similar lesions have been reported in loggerhead turtles (Herbst, 1994). Previous studies suggest that turtles in coastal habitats with nearby human disturbance have a greater incidence of GTFP (Herbst and Klein, 1995). Turtles with GTFP are chronically stressed and immunosuppressed (Aguirre et al., 1995). Spirorchidiasis has been reported in loggerheads (Wolke et al., 1982). Severe infestations of spirorchid (blood flukes) result in emaciation, anemia, and enteritis, or conversely, emaciation and anemia could render a turtle more susceptible to spirorchid infestation. Infestations can result in death or make turtles more susceptible to mortality stemming from other stresses (Wolke et al., 1982).

Summary and Conclusion

Activities considered under the cumulative scenario may harm sea turtles and their habitats. Those activities include structure installation, dredging, water quality and habitat degradation, OCS-related trash and flotsam, vessel traffic, seismic surveys, explosive structure removals, oil spills, oil-spill response activities, natural catastrophes, pollution, dredge operations, vessel collisions, commercial and recreational fishing, human consumption, beach lighting, and power plant entrainment. Sea turtles could be killed or injured by chance collision with service vessels or eating marine debris, particularly plastic items, lost from OCS structures and service vessels. It is expected that deaths due to structure removals would rarely occur due to mitigation measures (e.g., NOAA Fisheries Observer Program). The presence of, and noise produced by, service vessels and by the construction, operation, and removal of drill rigs may cause physiological stress and make animals more susceptible to disease or predation, as well as disrupt normal activities. Contaminants in waste discharges and drilling muds might indirectly affect sea turtles through food-chain biomagnification; there is uncertainty concerning the possible effect. Oil spills and oil-spill response activities are potential threats that may be expected to cause turtle deaths. Contact with, and consumption of oil and oil-contaminated prey, may seriously impact turtles. Sea turtles have been seriously harmed by oil spills in the past. The majority of OCS activities are estimated to be sublethal (behavioral effects and nonfatal exposure to intake of OCS-related contaminants or debris). Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or productivity, resulting in either acute or gradual population declines. The incremental contribution of a proposed action to cumulative impacts on sea turtles is slight.

4.5.7. Impacts on the Alabama, Choctawhatchee, St. Andrew, and Perdido Key Beach Mice

This cumulative analysis considers the effects of OCS-related and non-OCS-related impact-producing factors related to (1) oil and gas operations for the proposed multisale actions, prior and future OCS sales, and import tankering; (2) alteration and destruction of habitat by oil-spill cleanup with accompanying motorized traffic, dredge-and-fill activities by residential and commercial coastal construction and associated vehicular traffic, and natural catastrophes; (3) predation and competition in the ecological community; and (4) beach trash and debris. The effects from these major impact-producing factors are described below. This analysis incorporates the discussion of the effects from these impact-producing factors on beach mice in Chapters 4.2.1.7 and 4.4.3.7.

Oil spills can result from import tankering, barging, platform accidents, pipeline malfunctions, and other sources (Table 4-19). Spilled oil can cause skin and eye irritation, asphyxiation from inhalation of toxic fumes, food reduction, food contamination, increased predation, and displacement from preferred habitat. Contamination of food (for example, oiling of sea oat grains) may result in oil ingestion or make food tasteless or distasteful. The effects of oil that contacts a beach mouse are mentioned above. A slick cannot wash over the foredunes into beach mouse habitat unless carried by a heavy storm swell. Given the probabilities of a spill occurring, persisting long enough to reach beach mouse habitat, arriving ashore coincidentally with a storm surge, and affecting beach mice, impacts of oil spills on beach mice from the cumulative scenario are expected to be low.

In the event of an oil spill, protection efforts to prevent contact of these areas with spilled oil are mandated by the Oil Pollution Act of 1990. Vehicular traffic associated with oil-spill cleanup activities may degrade preferred habitat and cause displacement from these areas.

Present beach mice habitat is no longer of optimal quality because of historical beach erosion, construction, and tropical storm damage. Coastal construction can be expected to threaten beach mouse populations on a continual basis. Natural catastrophes including storms, floods, droughts, and hurricanes may substantially reduce or eliminate beach mice. Some of these are expected to occur and periodically contact beach mouse habitat.

Predation from both feral and nonferal domestic cats and dogs and competition with common house mice may also reduce and disturb their populations, but estimates of this mortality are unreliable (USDOI, FWS, 1987; Humphrey and Frank, 1992).

Trash and debris may be mistakenly consumed by beach mice or entangle them.

The beach mouse has a maximum expected lifespan of one year, and disturbances are not expected to last for more than one or two generations, provided some relict population survives.

Summary and Conclusion

Cumulative activities have a potential to harm or reduce the numbers of Alabama, Choctawhatchee, St. Andrew, and Perdido Key beach mice. Those activities include oil spills, alteration and reduction of habitat, predation and competition, and beach trash and debris. Most multisale-related spills, as well as oil spills stemming from import tankering and prior and future lease sales, are not expected to contact beach mice or their habitats. The expected incremental contribution of oil spill assumed in a proposed action (as analyzed in Chapter 4.4.3.7) to the cumulative oil-spill impact (as analyzed in Table 4-17) is negligible. Non-OCS activities or natural catastrophes could potentially deplete some beach mice populations to unsustainable levels, especially if reintroduction could not occur.

4.5.8. Impacts on Coastal and Marine Birds

This cumulative analysis considers the effects of impact-producing factors related to the proposed actions; prior and future OCS sales; State oil and gas activity; crude oil imports by tanker; and other commercial, military, and recreational offshore and coastal activities that may occur and adversely affect populations of nonendangered/nonthreatened and endangered/threatened birds. Air emissions; degradation of water quality; oil spills and spill-response activities; aircraft and vessel traffic and noise, including OCS helicopter and service-vessels; habitat loss and modification resulting from coastal construction and development; OCS pipeline landfalls and coastal facility construction; and trash and debris are OCS-related sources of potential adverse impacts. Non-OCS impact-producing factors include habitat degradation; disease; bird watching activities; fisheries interactions; storms and floods; pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge; and collisions of coastal and marine birds with structures such as power line towers. This analysis incorporates the discussion of the effects from these impact-producing factors on coastal and marine birds in Chapters 4.2.1.8 and 4.3.1.7 with additional information as cited.

Chapters 4.2.1.4, 4.3.1.4, and 4.5.4 consider air emissions including the amount of sulfur dioxide expected to be released due to a proposed action as well as from prior and future OCS sales, and State oil and gas activity. These emissions may adversely affect coastal and marine birds. Pollutant emission into the atmosphere from the activities under the cumulative analysis are projected to have minimum effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations. Onshore impact on air quality from emissions under the OCS cumulative analysis is estimated to be within both Class I and Class II PSD allowable increments as applied to the respective subareas. Emissions of pollutants into the atmosphere under the cumulative analysis are projected to have little effect on onshore air quality because of the atmospheric regime, the emission rates, and the distance of these emissions from the coastline. These judgments are based on average steady state conditions and the dispersion equation for concentration estimates; however, there will be days of low mixing heights and wind speeds that could further decrease air quality. These conditions are characterized by fog formation, which in the Gulf averages about 30-40 days a year, mostly during winter. Impacts from offshore sources are reduced in winter because the frequency of onshore winds decreases (19-34%) and the removal of pollutants by rain increases. The summer is more conducive to air quality effects as onshore winds occur more frequently, approximately 52-85 percent of the time. Increases in onshore annual average concentrations of NO_x, SO_x, and PM_{10} under the cumulative analysis are estimated to be less than Class I and Class II PSD allowable increments for the respective subareas per both the steady state and plume dispersion analyses, and are below concentrations that could harm coastal and marine birds. Indirect impacts on coastal and marine birds due to direct impacts on air quality under the cumulative analysis will have a negligible effect on coastal and marine birds.

Degradation of coastal and inshore water quality resulting from factors related to the proposed actions plus those related to prior and future OCS sales; crude oil imports by tanker; and other commercial, military, and recreational offshore and coastal activities is expected to impact coastal and marine birds. The effects of the cumulative activities scenario on coastal water quality is analyzed in detail in Chapter 4.5.3.1. There exists a wide variety of contaminant inputs into coastal waters bordering the Gulf of Mexico. The dominant pollution source is the large volume of water from the Mississippi River, which drains over two-thirds of the contiguous United States. Major activities that have added to the contamination of Gulf coastal waters include the petrochemical industry, agriculture, forestry, urban expansion, extensive dredging operations, municipal sewerage treatment processes, marinas and recreational boating, maritime shipping, and hydromodification activities. Not as significant are large commercial waste disposal operations, livestock farming, manufacturing industry activities, power plant operations, and pulp and paper mills. Vessel traffic is likely to impact water quality through routine releases of bilge and ballast waters, chronic fuel and tank spills, trash, and domestic and sanitary discharges. Projected large oil spills represent an acute significant impact to coastal waters while small spills serve as a low-level, chronic source of petroleum contamination to regional coastal water quality.

Coastal and marine birds will likely experience chronic physiological stress from sublethal exposure to or intake of contaminants or discarded debris. This will cause disturbances and displacement of single birds or flocks. Chronic sublethal stress is often undetectable in birds. It can serve to weaken individuals (especially serious for migratory species) making them susceptible to infection and disease. The extensive oil and gas industry operating in the Gulf area has caused low-level, chronic, petroleum contamination of coastal waters. Lethal effects are expected primarily from uncontained inshore oil spills and associated spill response activities in wetlands and other biologically sensitive coastal habitats. Primary physical effects are oiling and the ingestion of oil, and secondary effects are the ingestion of oiled prey. Recruitment of birds through successful reproduction is expected to take up to many years, depending upon the species and existing conditions. In Chapter 4.4.3.8 generic effects of oil on raptors, pelicans and plovers is discussed.

Helicopter and service-vessel traffic related to OCS activities could sporadically disturb feeding, resting, or nesting behavior of birds or cause abandonment of preferred habitat. The FAA (Advisory Circular 91-36C) and corporate helicopter policy states that helicopters must maintain a minimum altitude of 700 ft while in transit offshore, and 500 ft while working between platforms. When flying over land, the specified minimum altitude is 1,000 ft over unpopulated areas or across coastlines and 2,000 ft over populated areas and biologically sensitive areas such as wildlife refuges and national parks. Generic importance of the flight altitude regulation to birds is discussed in Chapters 4.2.1.8 and 4.3.1.7. The net effect of OCS-related flights on coastal and marine birds is expected to result in sporadic disturbances, which may result in displacement of localized groups. During nesting periods, this could ultimately result in some reproductive failure from nest abandonment or predation on eggs and young when a parent is flushed from a nest.

An average of 300,000 OCS-related service-vessel trips may occur annually under the cumulative activities scenario. Service vessels will use selected nearshore and coastal (inland) navigation waterways, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. Routine presence and low speeds of service vessels within these waterways diminishes the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. It is expected that service-vessel traffic will seldom disturb populations of coastal and marine birds existing within these areas. Recreational vessel traffic is a much greater source of impact to birds in coastal habitats. These vessels are, in most cases, not required to comply with strict speed/wake restrictions (small recreational fishing boats, ski boats, etc.) often flush coastal and marine birds from feeding, resting, and nesting areas. Such disturbances displace local groups from these preferred habitats and could lead to abandonment of the areas in general or reproductive failure. Disturbance may result in increased energy expenditures due to avoidance flights and decreased energy intake due to interference with feeding activity. It is estimated that the effects of non-OCS vessel traffic on birds within coastal areas are substantial.

Historic census data shows that many of these species are declining in numbers and are being displaced from areas along the coast (and elsewhere) as a result of the encroachment of their preferred habitat(s) by the aforementioned sources. As these birds move to undisturbed areas of similar habitat, their presence may create or augment habitat utilization pressure on these selected areas as a result of intra- and interspecific competition for space and food. Under the cumulative activities scenario, factors contributing to coastal land loss or modification include construction of approximately 23-38 pipeline landfalls (State and OCS), 140-280km of onshore pipeline (OCS and State), and potentially 4-16 gas processing plants (OCS only) as well as other facilities. The contribution of development from urban and other industrial growth will be substantial, causing both the permanent loss of lands and increased levels of disturbance associated with new construction and facilities.

Coastal and marine birds are commonly entangled and snared in discarded trash and debris. Many species will readily ingest small plastic debris, either intentionally or incidentally. Interaction with plastic materials may lead to permanent injuries and death. Much of the floating material discarded from vessels and structures offshore drifts ashore or remains within coastal waters. These materials include lost or discarded fishing gear such as gill nets and monofilament lines, which cause the greatest damage to birds. It is expected that coastal and marine birds will seldom become entangled in or ingest OCS-related trash and debris as a result of MMS prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, MARPOL, Annex V, Public Law 100-220 (101 Statute 1458), which prohibits the disposal of any plastics at sea or in coastal waters, went into effect January 1, 1989. Despite these regulations, quantities of plastic materials are accidentally discarded and lost in the marine environment, and so remain a threat to individual birds within these areas.

Non-OCS impact-producing factors include habitat degradation; disease; bird watching activities; fisheries interactions; storms and floods; pollution of coastal waters resulting from municipal, industrial, and agricultural runoff and discharge; and collisions of coastal and marine birds with structures such as power line towers. Coastal storms and hurricanes can often cause deaths to coastal birds through high winds; associated flooding destroys active nests. Nesting territories and colonial bird rookeries with optimum food and/or nest-building materials may also be lost. Elevated levels of municipal, industrial, and agricultural pollutants in coastal wetlands and waters expose resident birds to chronic physiological stress. Collisions with power lines and supporting towers can occur during inclement weather and during periods of migration, often causing death or permanent injury to birds (Avery et al., 1980; Avian Power Line Interaction Committee, 1994). Vital habitat needs to be protected so that the life-support system continues for the birds and their prey. Habitat alteration has the potential to disrupt social behavior, food supply, and health of birds that occur in the Gulf of Mexico. Such activities may stress the animals and cause them to avoid traditional feeding and breeding areas or migratory routes. Commercial fisheries may accidentally entangle and drown or injure birds during fishing operations or by lost and discarded fishing gear. Competition for prey species may also occur between birds and fisheries.

Summary and Conclusion

Activities considered under the cumulative activities scenario will detrimentally affect coastal and marine birds. It is expected that the majority of effects from the major impact-producing factors on coastal and marine birds are sublethal (behavioral effects and nonfatal exposure to or intake of OCS-related contaminants or discarded debris) and will usually cause temporary disturbances and displacement of localized groups inshore. The net effect of habitat loss from oil spills, new construction, and maintenance and use of pipeline corridors and navigation waterways will alter species composition and reduce the overall carrying capacity of disturbed area(s) in general.

The incremental contribution of a proposed action (Chapters 4.2.1.8 and 4.3.1.7 to the cumulative impact is negligible because the effects of the most probable impacts, such as sale-related operational discharges and helicopters and service-vessel noise and traffic, are estimated to be sublethal and some displacement of local individuals or groups may occur. It is expected that there will be little interaction between OCS-related oil spills and coastal and marine birds.

The cumulative effect on coastal and marine birds is expected to result in a discernible decline in the numbers of birds that form localized groups or populations, with associated change in species composition and distribution. Some of these changes are expected to be permanent, as exemplified in historic census data, and to stem from a net decrease in preferred and/or critical habitat.

4.5.9. Impacts on the Gulf Sturgeon

This cumulative analysis considers the effects of impact-producing factors related to (1) oil spills involving the proposed actions and prior and future OCS sales; (2) dredge-and-fill operations and natural catastrophes that alter or destroy habitat, and (3) commercial fishing on the Gulf sturgeon. Sections providing supportive material for the Gulf sturgeon analysis include Chapters 3.2.8 (description of Gulf sturgeon), 4.4.1.1.3.1(offshore oil spills), 4.4.1.1.3.2 (coastal oil spills), 4.1.1-4.1.2 (other major onshore/coastal activities), and 4.1.3.4 (non-OCS oil spills).

Extant occurrences of Gulf sturgeon in 1993 extended from Lake Pontchartrain in southeastern Louisiana to Charlotte Harbor in western Florida (USDOI, FWS and Gulf States Marine Fisheries Commission, 1994). Although spawning may occur from the Pearl River in western Mississippi eastward, the most important spawning populations occur within the Florida Panhandle in the Apalachicola and Suwannee Rivers (Patrick, personal communication, 1996). Spawning grounds are located upriver in bottomland hardwood forested wetlands that are flooded during winter, not within coastal wetlands (Barkuloo, 1988; Clugston, 1991).

The direct effects of spilled oil on Gulf sturgeon occur through the ingestion of oil or oiled prey and the uptake of dissolved petroleum through the gills by adults and juveniles. Contact with or ingestion/absorption of spilled oil by adult Gulf sturgeon can result in mortality or sublethal physiological impact, especially irritation of gill epithelium and disturbance of liver function.

For spills greater than or equal to 1,000 bbl, concentrations of oil below the slick are within the range that cause sublethal effects on marine organisms. The maximum observed concentration of 1.5 ppm was observed at depth of 2 m below the slick from the 1979 *Ixtoc* blowout (McAuliffe, 1987). This value is within the range of LC_{50} values for many marine organisms; such values are typically 1-100 ppm for adults and subadults (Connell and Miller, 1981; Capuzzo, 1987). However, when exposure time beneath accidental spills, hydrocarbon composition, and the change in this composition during weathering are considered, exposure doses (measured as ppm-hr) are assumed to be far less than doses reported to cause even sublethal effects (McAuliffe, 1987). Given the low probability of occurrence, low probability that the low-population Gulf sturgeon would occur in the specific area when a spill occurs, small likelihood of contact of a surface oil slick with a demersal fish and its benthic habitat, and minimal concentrations of toxic oil relative to levels that would be toxic to adult or subadult Gulf sturgeon, the impacts of spilled oil on this endangered subspecies are expected to be very low.

It is expected that the extent and severity of effects from oil spills will be lessened by active avoidance of oil spills by adult sturgeon. Sturgeon are demersal and would forage for benthic prey well below an oil slick on the surface. Adult sturgeon only venture out of the rivers into the marine waters of the Gulf for roughly three months during the coolest weather. This reduces the likelihood of sturgeon coming into contact with oil. It is expected that contact will cause sublethal irritation of gill epithelium and an increase in liver function for less than a month. Tarballs resulting from the weathering of oil "are found floating at or near the surface" (NRC, 1985) with no effects expected to demersal fishes such as the Gulf sturgeon.

Natural catastrophes and non-OCS activities such as dredge-and-fill may destroy Gulf sturgeon habitat. Natural catastrophes including storms, floods, droughts, and hurricanes can result in substantial habitat damage. Loss of habitat is expected to have a substantial effect on the reestablishment and growth of Gulf sturgeon populations.

Dredge-and-fill activities occur throughout the nearshore areas of the United States. They range in scope from propeller dredging (scarring) by recreational boats to large-scale navigation dredging and fill for land reclamation. Non-OCS operations, such as dredge-and-fill activities and natural catastrophes, indirectly impact Gulf sturgeon through the loss of spawning and nursery habitat.

Commercial fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may impact species other than the target species. For example, Gulf sturgeon are a small part of the shrimp bycatch. It is estimated that for every 0.5 kilograms (kg) of shrimp harvested, 4 kg of bycatch is discarded (Sports Fishing Institute, 1989). The death of several Gulf sturgeon is expected from commercial fishing.

Summary and Conclusion

The Gulf sturgeon can be impacted by activities considered under the cumulative scenario, activities such as oil spills, alteration and destruction of habitat, and commercial fishing. The effects from contact with spilled oil will be sublethal and last for less than one month. Substantial damage to Gulf sturgeon habitats is expected from inshore alteration activities and natural catastrophes. As a result, it is expected that the Gulf sturgeon will experience a decline in population sizes and a displacement from their current distribution that will last more than one generation. Deaths of adult sturgeon are expected to occur from commercial fishing. The incremental contribution of a proposed action (as analyzed in Chapter 4.2.1.9) to the cumulative impact is negligible because the effect of contact between sale-specific oil spills and Gulf sturgeon is expected to be sublethal and last less than one month.

4.5.10. Impacts on Fish Resources and Essential Fish Habitat

This cumulative analysis considers activities that could occur and adversely affect fish resources and essential fish habitat (EFH) in the north-central and northwestern Gulf of Mexico during the years 2003-2042. These activities include effects of the OCS Program (proposed actions, and prior and future OCS sales), State oil and gas activity, coastal development, crude oil imports by tanker, commercial and recreational fishing, and natural phenomena. Specific types of impact-producing factors considered in this cumulative analysis include coastal environmental degradation; marine environmental degradation; commercial and recreational fishing techniques or practices; hypoxia; red or brown tides; hurricanes; removal of production structures; petroleum spills; subsurface blowouts; pipeline trenching; and offshore discharges of drilling muds and produced waters.

Healthy fishery stocks depend on EFH waters and substrate necessary to fish for spawning, breeding, feeding, and growth to maturity. Due to the wide variation of habitat requirements for all life history stages (as described in Chapter 3.2.9) for marine species, EFH for the Gulf of Mexico includes all coastal and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone (EEZ). The effects of cumulative actions on coastal wetlands and coastal water quality are analyzed in detail in Chapters 4.5.1.2 and 4.5.3.1, respectively. Collectively, the adverse impacts from these effects are called coastal environmental degradation. The effects of cumulative actions on offshore live bottoms and marine water quality are analyzed in detail in Chapters 4.5.2.1 and 4.5.3.2, respectively. Collectively, the adverse impacts from these effects are called marine environmental degradation. The direct and/or indirect effects from cumulative coastal and marine environmental degradation on EFH and commercial fisheries are summarized and considered below.

Conversion of wetlands for agricultural, residential, and commercial uses has been substantial. The trend is projected to continue into the future, although at a slower rate in consideration of regulatory pressures. The most serious impact to EFH is the cumulative effects on wetlands that are occurring at an ever-increasing rate as the Gulf States' populations increase (GMFMC, 1998). Residential, commercial, and industrial developments are directly impacting EFH by dredging and filling coastal areas or by affecting the watersheds.

The cumulative impacts of pipelines to wetlands are described in Chapter 4.5.1.2. Permitting agencies require mitigation of many of these impacts. Unfortunately, many of these efforts are not as productive as intended. The MMS and USGS are performing a study of these problems to help identify solutions.

Canal dredging primarily accommodates commercial, residential, and recreational development. Increased population and commercial pressures on the coasts of all Gulf states in the CPA and WPA are also causing the expansion of ports and marinas there. Where new channels are dredged, wetlands would be adversely impacted by the channel, disposal of dredged materials, and the development that it attracts.

The continuing erosion of waterways maintained by the COE is projected to adversely impact productivity of wetlands along channel banks. Expansion of tidal influence, saltwater intrusion, hydrodynamic alterations, erosion, sediment export, and habitat conversion can be significant in basins with low topographic relief, as seen in deltaic Louisiana. Secondary impacts are projected to generate the loss of wetlands over the next 30-40 years, primarily in Louisiana.

Other factors that impact coastal wetlands include marsh burning, marsh-buggy traffic, and well-site construction. Tracks left by marsh buggies open new routes of water flow through relatively unbroken marsh and can persist for up to 30 years, thereby inducing and accelerating erosion and sediment export. Well-site construction activities include board roads, ring levees, and impoundments.

Conversion of wetland habitat is projected to continue in the foreseeable future. Within the northern Gulf coastal areas, river channelization and flood protection have greatly restricted the most effective wetland creation activities. Flood control has fostered development, which has most impacted wetlands and reduced their area.

State oil production and related activities, especially in Texas, Louisiana, and Alabama, are projected to have greater and more frequent adverse impacts on wetlands than would the OCS Program offshore activities, because of their proximity. Construction of new facilities will be more closely scrutinized, although secondary impacts on wetlands will continue to be the greatest and should receive greater attention.

The present number of major navigation canals appears to be adequate for the OCS Program and most other developments. Some of these canals may be deepened or widened. Navigation canal construction will continue in coastal Louisiana and will be an important cause of wetland loss there. Secondary impacts of canals to wetlands will continue to cause impacts.

The incremental contribution of the proposed actions (Chapters 4.2.1.1.2 for the CPA, 4.3.1.1.2 for the WPA and 4.4.3.1.2 for accidental events) would be a very small part of the cumulative impacts to wetlands.

The coastal waters of Texas, Louisiana, Mississippi, Alabama, and the Florida Panhandle are expected to continue to experience nutrient enrichment, low-dissolved oxygen, and toxin and pesticide contamination, resulting in the loss of both commercial and recreational uses of the affected waters. Fish kills, shellfish-ground closures, and restricted swimming areas will likely increase in numbers over the next 30-40 years. Degradation of water quality is expected to continue due to contamination by point- and nonpoint-source discharges and spills due to eutrophication of waterbodies, primarily due to runoff and hydrologic modifications. Contamination of the coastal waters by natural and manmade noxious compounds coming from point and nonpoint sources and accidental spills derived from both rural and urban sources will be both localized and pervasive. Runoff and wastewater discharge from these sources will cause water quality changes that will result in a significant percentage of coastal waters not attaining Federal water quality standards. Increased turbidity from extensive dredging operations projected to continue within the coastal zone constitutes another considerable type of pollution. Contamination from oil and hazardous substance spills should be primarily localized and not long term enough to preclude designated uses of the waters.

The incremental contribution of the proposed actions (Chapters 4.2.1.3.1 for the CPA, 4.3.1.3.1 for the WPA and 4.4.3.3.1 for accidental impacts) would be a very small part of the cumulative impacts to coastal water quality. Localized, minor degradation of coastal water quality is expected from the proposed actions within the immediate vicinity of the waterbodies proximate to the proposed service bases, commercial waste-disposal facilities, and gas processing plants as a result of routine effluent discharges and runoff. Only a very small amount of dredging would occur as a result of the proposed actions.

Non-OCS sources of impacts on biological resources and the structure of live bottoms include natural disturbances (e.g., turbidity, hypoxia, and storms), anchoring by recreational and commercial vessels, and commercial and recreational fishing. These impacts may result in severe and permanent mechanical damages to live-bottom communities that serve as essential fish habitat.

Commercial fishing activities that could impact live bottoms would include trawl fishing and trap fishing. With the exception of localized harvesting techniques, most wild-caught shrimp are collected using bottom trawls – nets towed along the seafloor – held apart with heavy bottom sled devices called “doors” made of wood or steel. In addition to the nonselective nature of bottom trawls, they can be potentially damaging to the bottom community as they drag. Trawls pulled over the bottom disrupt the communities that live on and just below the surface and also increases turbidity of the water (GMFMC, 1998).

Throughout the Gulf Coast, commercial trap fishing is used for the capture of reef fish, and commercial and recreational trap fishing is used for the capture of spiny lobster, stone crab, and blue crab. Reef fish traps are primarily constructed of vinyl-covered wire mesh and include a tapered funnel where the fish can enter but not escape. Traps, like trawls, can potentially damage the bottom community, depending on where they are placed. If they are deployed and retrieved from coral habitats or live bottom, they can damage the corals and other attached invertebrates on the reef. Seagrasses can also be broken or killed by placement and retrieval of traps (GMFMC, 1998).

The OCS-related activities could impact the biological resources and the structure of live bottoms by the anchoring of vessels, emplacement of structures (drilling rigs, platforms, and pipelines), sedimentation (operational waste discharges, pipeline emplacement, explosive removal of platforms, and blowouts), and chemical contamination (produced water, operational waste discharges, and petroleum spills). The Live Bottom (Pinnacle Trend) Stipulation (in the CPA), and the Topographic Features Stipulation (in the CPA and WPA) would prevent most of the potential impacts on live-bottom communities and EFH from the

OCS Program and from bottom-disturbing activities (anchoring, structure emplacement and removal, pipeline trenching), operational offshore waste discharges (drilling muds and cuttings, produced waters), and blowouts. Recovery from impacts caused by unregulated operational discharges or an accidental blowout would take place within several years. For any activities associated with the proposed actions, USEPA's Region 4, in the northeast part of the CPA, and Region 6 for the rest of the CPA and WPA, will regulate discharge requirements through their USEPA NPDES individual discharge permits. In the unlikely event of an offshore spill, the biological resources of hard/live bottoms would remain unharmed as the spilled substances could, at the most, reach the seafloor in minute concentrations. These minute quantities may cause very short-term sublethal effects (changes in physiology) in benthic organisms that will recover quickly.

Surface oil spills would have the greatest chance of impacting high relief live bottoms (includes topographic features and pinnacles) located in depths less than 20 m (mostly sublethal impacts). A comprehensive survey of all low relief live bottoms in the CPA and WPA has yet to be conducted but all major topographic features are well described and most of the Pinnacle Trend is well mapped and described (Chapters 3.2.2.1 and 3.2.2.2). Only three high-relief features in the Gulf rise to water depths shallower than 20 m. These are the East Flower Garden Bank (16 m), Stetson Bank (17 m) and Sonnier Bank (17 m). Subsurface spills (pipeline spills) could cause localized, sublethal (short-term, physiological changes) impacts on the live bottoms; however, such events would be highly unlikely since the protective lease stipulations would prevent oil lines from being installed in the immediate vicinity of high-relief live bottoms. The impact of OCS-related activities on the live bottoms of the cumulative activity area would probably be slight because community-wide impacts should not occur.

The incremental contribution of impacts on fisheries and EFH from the proposed actions (as analyzed in Chapters 4.2.1.3.1 for the CPA, 4.3.1.3.1 for the WPA, and 4.4.3.3.10 for accidental impacts) to the cumulative impacts would be small. The proposed actions would add slightly to the overall offshore water quality degradation through the disposal of offshore operational wastes and sedimentation/sediment resuspension. Other activities of the proposed actions potentially contributing to regional impacts would be the effects of petroleum spills and anchoring. The extent of these impacts would be limited by the implementation of the protective lease stipulations and the depths of all but three high-relief live bottom habitats (>20 m).

Municipal, agricultural, and industrial coastal discharges and land runoff would impact the health of marine waters. As the assimilative capacity of coastal waters is exceeded, there will be a subsequent, gradual movement of the area of degraded waters farther offshore over time. This degradation will cause short-term loss of the designated uses of some shallow offshore waters due to hypoxia and red or brown tide impacts and to levels of contaminants in some fish exceeding human health standards. Coastal sources are assumed to exceed all other sources, with the Mississippi River continuing to be the major source of contaminants to the north central Gulf area. Offshore vessel traffic and OCS operations would contribute in a small way to regional degradation of offshore waters through spills and waste discharges. All spill incidents (OCS and others) and activities increasing water-column turbidity are assumed to cause localized water quality changes for up to three months for each incident. The incremental contribution of the proposed actions to degradation of marine water quality would be small.

The impact of coastal and marine degradation from the OCS Program and non-OCS activities is expected to cause no more than a 10 percent decrease in fish populations or EFH. At the expected level of cumulative impact, the resultant influence on fish resources and EFH could be substantial and easily distinguished from effects due to natural population variations. The incremental contribution of the proposed actions to these cumulative impacts would be small and would be almost undetectable.

Competition between large numbers of commercial and recreational fishermen for a given fishery resource, as well as natural phenomena such as weather, hypoxia, and red or brown tides, may reduce fish resource standing populations. Fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as significantly impact species other than the target. Hypoxia and red or brown tides may impact fish resources and EFH by suffocating or poisoning offshore populations of finfish and shellfish and live-bottom reef communities. Finally, hurricanes may impact fish resources by destroying offshore live-bottom and reef communities and changing physical characteristics of inshore and offshore ecosystems.

Many of the important species harvested from the Gulf of Mexico are believed to have been overfished, while overfishing is still taking place (USDOC, NMFS, 2001b). The new managed species listed as overfished in 2000 that were not listed in 1999 are King mackerel, red snapper, red grouper, Nassau grouper, goliath grouper, and red drum. Continued fishing at the present levels may result in declines of fish resource populations and eventual failure of certain fisheries. It is expected that overfishing of targeted species and trawl fishery bycatch will adversely affect fish resources. The impact of overfishing on fish resources is expected to cause a measurable decrease in populations. At the estimated level of effect, the resultant influence on fish resources is expected to be substantial and easily distinguished from effects due to natural population variations.

Those species that are not estuary dependent, such as mackerel, cobia, and crevalle, are considered coastal pelagics. Populations of these species exhibit some degree of coastal movement. These species range throughout the Gulf, move seasonally, and are more abundant in the eastern portions of the northern Gulf during the summer (GMFMC, 1985). In general, the coastal movements of these species are restricted to one or two regions within the Gulf of Mexico region and are not truly migratory, as is the case with salmon. The coastal movements of these species are related to reproductive activity, seasonal changes in water temperature, or other oceanographic conditions. Discernible effects to regional populations or subpopulations of these species as a result of the OCS Program in the Gulf of Mexico area are not expected because pelagic species are distributed and spawn over a large geographic area and depth range.

Removal of structures by using explosives results in loss of artificial habitat and causes fish kills. It is estimated that 3,676-4,183 structures would be removed using explosives as a result of the OCS Program in the CPA and 629-783 in the WPA. An estimated 4-5 structures will be removed from the EPA area between 2003-2042. It is expected that structure removals would have a major effect on fish resources near the removal sites. However, only those fish proximate to the removal sites would be killed and these expected impacts to fish resources have been shown to be small overall, and would not alter determinations of status for impacted species or result in changes in management strategies (Gitschlag et al., 2000).

In the following analysis, the estimates of impacts to fish resources from petroleum spills comes from examinations of recent spills such as the *North Cape*, Breton Point, *Sea Empress*, and *Exxon Valdez* (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). The amount of petroleum spilled by each event and its estimated impact to fish resources was used as a guideline to estimate the impacts to fisheries in this EIS.

Spills that contact coastal bays, estuaries, and offshore waters when pelagic eggs and larvae are present have the greatest potential to affect fish resources. If spills were to occur in coastal bays, estuaries, or waters of the OCS proximate to mobile adult finfish or shellfish, the effects would likely be sublethal and the extent of damage would be reduced due to the capability of adult fish and shellfish to avoid a spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. For eggs and larvae contacted by spilled diesel, the effect is expected to be lethal.

It is estimated that 1,875 coastal spills of <1,000 bbl will occur along the northern Gulf Coast annually (Table 4-17). About 95 percent of these spills are projected to be from non-OCS-related activity. Of coastal spills <1,000 bbl, the assumed size is 6 bbl therefore, the great majority of coastal spills would affect a very small area and dissipate rapidly. The small coastal spills that do occur from OCS-related activity would originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, and Alabama but primarily within the Houston/Galveston area of Texas and the Deltaic area of Louisiana. It is expected that small coastal oil spills from non-OCS sources would often affect coastal bays and marshes essential to the well-being of the fish resources and EFH.

It is estimated that 10-15 coastal spills ≥1,000 bbl from all sources would occur annually along the northern Gulf (Table 4-17). Between 80 and 100 percent of these spills are expected to be non-OCS related (Table 4-17). One large (≥1,000 bbl) coastal spill is projected to originate from OCS-related activity annually. A large coastal spill that could occur from OCS-related activity would likely originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, or Alabama, but primarily within the Houston/Galveston area of Texas and the Deltaic area of Louisiana. It is expected that large coastal spills from non-OCS sources would often affect coastal bays and marshes essential to the well-being of the fishery resources and EFH in the cumulative activity area.

A total of 4-5 large (≥1,000 bbl) offshore spills are projected to occur annually from all sources Gulf wide. One large (≥1,000 bbl) offshore spill is estimated to occur every 1 to 2 years from the Gulfwide OCS Program (Table 4-17). A total of 1,550 to 2,150 smaller offshore spills (<1,000 bbl) are projected annually Gulfwide. The majority of these (1,350-1900) will originate from OCS program sources. Chapter 4.4.1.1 describes projections of future spill events in more detail. The OCS-related spills in the cumulative area are expected to cause a 1 percent or less decrease in fish resources. The impact of non-OCS-related spills in this area is expected to cause a 10 percent or less decrease in fish resources.

Subsurface blowouts of both oil and natural gas wells and pipeline trenching have the potential to affect adversely commercial fishery resources. Loss of well control and resultant blowouts seldom occur on the Gulf OCS (7 blowouts per 1,000 well starts; <10% would result in some spilled oil). Considering the entire OCS program from 2003 to 2042, it is projected that there would be 164-192 blowouts in the CPA, 51-66 in the WPA, and only 1 blowout in the EPA. In addition, sediment would be resuspended during the installation of pipelines. Sandy sediments would be quickly redeposited within 400 m of the crater, and finer sediments would be widely dispersed and redeposited over a period of hours to days within a few thousand meters of the crater. Resuspension of vast amounts of sediments due to hurricanes occurs on a regular basis in the northern Gulf of Mexico (Stone et al., 1996). It is expected that the infrequent subsurface blowout that may occur on the Gulf OCS would have a negligible effect on fish resources. The effect on fish resources from pipeline trenching is expected to cause a 5 percent or less decrease in standing stocks. Drilling-mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than those found more than a few meters from the discharge point. Offshore discharges of drilling muds would dilute to very near background levels within 1,000 m of the discharge point and would have a negligible effect on fisheries. Produced-water discharges contain components and properties detrimental to commercial fishery resources. Moderate petroleum and metal contamination of sediments and the water column would occur out to several hundred meters downcurrent from the discharge point. Offshore discharges of produced water would disperse, dilute to very near background levels within 1,000 m of the discharge point, and have a negligible effect on fisheries. Offshore live bottoms will not be impacted. Offshore discharges and subsequent changes to marine water quality will be regulated by a USEPA NPDES permits.

Summary and Conclusion

Activities resulting from the OCS Program and non-OCS events in the northern Gulf of Mexico have the potential to cause detrimental effects on fish resources and EFH. Impact-producing factors of the cumulative scenario that are expected to substantially affect fish resources and EFH include coastal and marine environmental degradation, overfishing, petroleum spills, and pipeline trenching. At the estimated level of cumulative impact, the resultant influence on fish resources and EFH is expected to be substantial, but not easily distinguished from effects due to natural population variations.

The incremental contribution of the proposed actions' impacts on fish resources and EFH (as analyzed in Chapters 4.2.1.10 for the CPA, 4.3.1.8 for the WPA, and 4.4.3.10 for accidental impacts) to the cumulative impact is small. The effects of impact-producing factors (coastal and marine environmental degradation, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters) related to the proposed actions are expected to be negligible (resulting in less than a 1% decrease in fish populations or EFH) and almost undetectable among the other cumulative impacts.

The cumulative impact is expected to result in a less than 10 percent decrease in fish resource populations or EFH. It would require 2-3 generations for fishery resources to recover from 99 percent of the impacts. Recovery cannot take place from habitat loss.

4.5.11. Impacts on Commercial Fisheries

This cumulative analysis considers activities that could occur and adversely affect commercial fishing for the years 2003-2042. These activities include effects of the OCS Program (proposed action and prior and future OCS sales), State oil and gas activity, the status of commercial fishery stocks, oil transport by tankers, natural phenomena, and commercial and recreational fishing. Specific types of impact-producing factors considered in this cumulative analysis include commercial and recreational fishing techniques or practices, hurricanes, installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters.

Competition between large numbers of commercial fishermen, between commercial operations employing different fishing methods, and between commercial and recreational fishermen for a given fishery resource, as well as natural phenomena such as hurricanes, hypoxia, and red or brown tides, may impact commercial fishing activities. Fishing techniques such as trawling, gill netting, or purse seining, when practiced nonselectively, may reduce the standing stocks of the desired target species as well as significantly impact species other than the target. In addition, continued fishing of most commercial species at the present levels may result in rapid declines in commercial landings and eventual failure of certain fisheries. These effects will likely result in State and Federal constraints, such as closed seasons, excluded areas, quotas, size and weight limits on catch, and gear restrictions on commercial fishing activity. Space-use conflicts and conflicts over possession of the resources can result from different forms of commercial operations and between commercial and recreational fisheries. These effects will likely result in State and Federal constraints, such as weekday only, quotas, and/or gear restrictions, on commercial fishing activity. Finally, hurricanes may impact commercial fishing by damaging gear and shore facilities and dispersing resources over a wide geographic area. The availability and price of key supplies and services, such as fuel, can also affect commercial fishing. The impact from the various factors described above is expected to result in a 10 percent or less decrease in commercial fishing activity, landings, or value of landings.

A range of 2,360-3,134 structures is projected to be installed as a result of the OCS Program in the CPA, 622-856 in the WPA, and 5-9 in the EPA. Approximately 88-89 percent of these installations are in typical trawling water depths of 200 m or less. If all of the structures are major production structures, a maximum of 18,804, 5,136 and 54 ha (6 ha per platform) would be eliminated from trawl fishing for up to 40 years from the CPA, WPA, and EPA, respectively. It is assumed that the total area lost to commercial fishing due to the presence of OCS production platforms would continue to be less than 1 percent of the total area available to commercial trawl fishing. For example, the maximum number of 18,804 structures installed in the CPA represents only 0.1 percent of the total area of the Central Planning Area. It is expected that platform emplacement would infrequently affect trawling activity.

Structure removals result in artificial habitat loss and cause fish kills when explosives are used. It is estimated that 3,676-4,183 structures would be removed using explosives as a result of the OCS Program in the CPA and 629-783 in the WPA. An estimated 4-5 structures will be removed from the EPA area between 2003-2042. It is expected that structure removals will have a negligible effect on commercial fishing because of the inconsequential number of removals and the consideration that removals kill only those fish proximate to the removal sites. However, only those fish proximate to the removal sites would be killed and these expected impacts to fish resources have been shown to be small overall, and would not alter determinations of status for impacted species or result in changes in management strategies (Gitschlag et al., 2000).

Seismic surveys will occur in both shallow and deepwater areas of the Gulf of Mexico under the OCS Program. Usually, fishermen are precluded from a very small area for several days. This should not impact the annual landings or value of landings for commercial fisheries in the Gulf. Gulf of Mexico species can be found in many adjacent locations and Gulf commercial fishermen do not fish in one locale. Gear conflicts between seismic surveys and commercial fishing are also mitigated by the Fishermen's Contingency Fund. All seismic survey locations and schedules are published in the USCG Local Notice to Mariners, a free publication available to all fishermen. Seismic surveys will have a negligible effect on commercial fishing.

The potential causes, sizes, and probabilities of petroleum spills that could occur during activities associated with the proposed actions are discussed in Chapters 4.4.1.1. Information on spill response and cleanup is contained in Chapter 4.4.2. In the following analysis, the estimations of impacts to fisheries from oil spills come from examinations of recent spills such as the *North Cape*, *Breton Point, Sea Empress*, and *Exxon Valdez* (Brannon et al., 1995; Maki et al., 1995; Mooney, 1996; Pearson et al., 1995). The amount of oil spilled by each event and its estimated impact on fishing practices and fisheries economics was used as a guideline to estimate the impacts on commercial fishing under the OCS Program.

It is estimated that 1,875 coastal spills of <1,000 bbl will occur along the northern Gulf Coast annually (Table 4-17). About 95 percent of these spills are projected to be from non-OCS-related activity. Of coastal spills <1,000 bbl, the assumed size is 6 bbl; therefore, the great majority of coastal spills would affect a very small area and dissipate rapidly. The small coastal spills that do occur from

OCS-related activity would originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, and Alabama, but primarily within the Houston/Galveston area of Texas and the Deltaic area of Louisiana. It is expected that small, coastal oil spills from non-OCS sources would often affect coastal bays and marshes. Commercial fishermen will actively avoid the area of a spill. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches will prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area. This in turn could decrease landings and/or value of catch for several months.

It is estimated that 10-15 coastal spills >1,000 bbl would occur annually along the northern Gulf (Table 4-17). Between 80 and 100 percent of these spills are expected to be non-OCS related. Only one large coastal spill is projected to originate from OCS-related activity annually. A large coastal spill that could occur from OCS-related activity would likely originate near terminal locations in the coastal zone of Texas, Louisiana, Mississippi, or Alabama, but primarily within the Houston/Galveston area of Texas and the Deltaic area of Louisiana. It is expected that large coastal spills from non-OCS sources would often affect coastal bays and marshes essential to the well-being of the commercial fishery resources in the cumulative activity area.

A total of 4-5 large (≥1,000 bbl) offshore spills are projected to occur annually from all sources Gulfwide. Only 1 of these offshore spills is estimated to occur every 1 to 2 years from the Gulfwide OCS Program (Table 4-17).

A total of 1,550 to 2,150 smaller offshore spills (<1,000 bbl) are projected annually Gulfwide. The impact of OCS-related spills in the cumulative area is expected to cause a 1 percent or less decrease in commercial fishing. The impact of non-OCS-related spills in this area is expected to cause a 10 percent or less decrease in commercial fishing. At the expected level of impact, the resultant influence on commercial fishing, landings, or the value of those landings is expected to be considerable but not easily distinguished from effects due to natural population variations.

Subsurface blowouts of both oil and natural gas wells and pipeline trenching have the potential to adversely affect commercial fishery resources. Loss of well control and resultant blowouts seldom occur on the Gulf OCS (7 blowouts per 1,000 well starts; <10% would result in some spilled oil). Considering the entire OCS program from 2003 to 2042, it is projected that there would be 164-192 blowouts in the CPA, 51-66 in the WPA, and only 1 blowout in the EPA. In addition, sediment would be resuspended during the installation of pipelines. Sandy sediments would be quickly redeposited within 400 m of the trench, and finer sediments would be widely dispersed and redeposited over a period hours to days within a few thousand meters of the trench. Resuspension of vast amounts of sediments due to hurricanes occurs on a regular basis in the northern Gulf of Mexico (Stone et al., 1996). It is expected that the infrequent subsurface blowout that may occur on the Gulf OCS would have a negligible effect on commercial fishing. The effect on commercial fisheries from pipeline trenching is expected to cause a 5 percent or less decrease in commercial fishing, landings, or value of those landings. At the estimated level of effect, the resultant influence on commercial fishing is not expected to be easily distinguished from effects due to natural population variations.

Drilling-mud discharges contain chemicals toxic to marine fishes; however, this is only at concentrations four or five orders of magnitude higher than those found more than a few meters from the discharge point. Offshore discharges of drilling muds would dilute to very near background levels within 1,000 m of the discharge point and would have a negligible effect on fisheries.

Produced-water discharges contain components and properties detrimental to commercial fishery resources. Moderate petroleum and metal contamination of sediments and the water column would occur out to several hundred meters downcurrent from the discharge point. Offshore discharges of produced water would disperse, dilute to very near background levels within 1,000 m of the discharge point, and have a negligible effect on fisheries.

Summary and Conclusion

Activities resulting from the OCS Program and non-OCS events have the potential to cause detrimental effects to commercial fishing, landings, and value of those landings. Impact-producing factors of the cumulative scenario that are expected to substantially affect commercial fishing include commercial and recreational fishing techniques or practices, hurricanes, installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, petroleum spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters. At the estimated level of cumulative impact, the resultant influence on commercial fishing, landings, and value of those landings is expected to be substantial and easily distinguished from effects due to natural population variations.

The incremental contribution of the proposed actions impacts to commercial fisheries (as analyzed in Chapters 4.2.1.11 for the CPA, 4.3.1.9 for the WPA and 4.4.3.11 for accidental impacts) to the cumulative impact is small. The effects of impact-producing factors (installation of production platforms, underwater OCS obstructions, production platform removals, seismic surveys, oil spills, subsurface blowouts, pipeline trenching, and offshore discharges of drilling muds and produced waters) related to a proposed action are expected to be negligible (less than a 1 percent decrease in commercial fishing, landings, or value of those landings) and almost undetectable among the other cumulative impacts.

The cumulative impact is expected to result in a less than 10 percent decrease in commercial fishing, landings, or value of those landings. It would require 3-5 years for fishing activity to recover from 99 percent of the impacts.

4.5.12. Impacts on Recreational Beaches

This cumulative analysis considers the effects of impact-producing factors related to the proposed actions (Chapters 4.2.1.12 and 4.3.1.10), plus those related to prior and future OCS sales, State offshore and coastal oil and gas activities throughout the Gulf of Mexico, tankering of crude oil imports, merchant shipping, commercial and recreational fishing, military operations, recreational use of beaches, and other offshore and coastal activities that result in debris, litter, trash, and pollution, which may adversely affect major recreational beaches. Specific OCS-related impact-producing factors analyzed include trash and debris, the physical presence of platforms and drilling rigs, support vessels and helicopters, oil spills, and spill clean-up activities. Other factors such as land development, civil works projects, and natural phenomena have affected, and will continue to affect, the quality of the beach environment and public use and appreciation of major recreational beaches. Ultimately, all these factors plus the health of the U.S. economy and the price of gasoline can affect the travel and tourism industry and the level of beach use along the U.S. Gulf Coast.

Trash and debris are a recognized problem affecting enjoyment and maintenance of recreational beaches along the Gulf Coast. From extensive aerial surveys conducted by NMFS over large areas of the Gulf of Mexico, floating offshore trash and debris was characterized by Lecke-Mitchell and Mullin (1997) as a ubiquitous, Gulfwide problem. Coastal and offshore oil and gas operations contributing to trash and debris washing up on Texas and Louisiana beaches (Miller and Echols, 1996; Lindstedt and Holmes, 1988). Annual reports from the results of the International Beach Cleanup each fall (Center for Marine Conservation, 1996-1998) indicate volunteers remove thousands of pounds of trash and debris from coastal recreational beaches from Texas to Florida. Regulatory, administrative, educational, and volunteer programs involving government, industry, environmental, school, and civic groups; specific marine user groups; and private citizens are committed to monitoring and reducing the beach litter problem Gulfwide.

Continued and expanded oil and gas operations throughout the Gulf of Mexico have contributed to the trash and debris on coastal beaches. Trash and debris detract from the aesthetic quality of beaches, can be hazardous to beach users, and can increase the cost of maintenance programs. Other offshore activities (such as merchant shipping; Naval operations; offshore and coastal commercial and recreational fishing, State offshore oil and gas activities), coastal activities (such as recreation; State onshore oil and gas activities; condominiums and hotels), and natural phenomena (such as storms, hurricanes, and river outflows) contribute to debris and pollution existing on the major Gulf of Mexico recreational beaches.

The OCS oil and gas industry has improved offshore waste management practices and evidenced a strong commitment to participate in the annual removal of trash and litter from recreational beaches affected by their offshore operations. Furthermore, MARPOL Annex V and the special efforts to generate cooperation and support from all Gulf user groups through the Gulf of Mexico Program should lead to a decline in the overall level of human-generated trash adversely affecting recreational beaches throughout the Gulf.

At present, there are approximately 4,000 OCS platforms on the Gulf of Mexico OCS. About 1,200 of these platforms are within visibility range (approximately 12 mi) of shore; most (about 1,000) are located in the CPA west of the Mississippi River. In the CPA east of the Mississippi River, less than 50

OCS platforms are within 12 mi of the Mississippi or Alabama coast. About 50 platforms are located within 12 mi of the shore in the WPA. Based on these numbers and peak-year projections, a maximum of about 1,200 OCS production structures will be visible from shore at one time and this number will drastically decrease during the 40-year analysis period as operations move into deeper water. Oil and gas operations in State waters off Texas, Louisiana, and Alabama are also visible form shore. Aesthetic impacts of the visible presence of offshore drilling rigs and platforms are unlikely to affect the level of beach recreation, but they may affect the experience of some beach users, especially at beach areas such as the Padre Islands National Seashore in Texas and the Gulf Islands National Wilderness Area on Mississippi's outer barrier islands.

Vessels and helicopter traffic servicing OCS operations will be seen and heard by beach users from time to time. Existing and future oil and gas developments in the State waters contribute to these impacts. Commercial and recreational maritime traffic add to the visual and noise impacts.

The primary impact-producing factors associated with offshore oil and gas exploration and development, and most widely recognized as major threats to the enjoyment and use of recreational beaches, are oil spills and offshore trash, debris, and tar. All of the respondents from a total of 39 semi-structured discussions conducted from March through May 1997 for the MMS study, "Socioeconomic and Environmental Issues Analysis of Oil and Gas Activity on the Outer Continental Shelf of the Western Gulf of Mexico," recognized environmental threats posed by the nature and specific operations of the industry (Kelley, in press). Most respondents to the study believed that a major oil spill would have devastating effects on the tourist industry. While "small" spills were deemed to occur with some frequency, it is "the big one" that people most fear. Offshore trash and tar is often noted as the second biggest threat to the conditions of the beaches in the Gulf of Mexico coastal region. Additional factors such as the physical presence of platforms and drilling rigs can affect the aesthetics of beach appreciation. Soil contamination and air and water pollution created by the refining of oil and the production of petrochemical products are other areas of concern.

Section 4.4.1 discusses the risk of spill occurrence, the number of spills estimated for the OCS Program, and the likelihood of an OCS-spill contacting the Gulf Coast. The scenarios analyzed are a hypothetical oil spills of 4,600 bbl and ≥10,000 bbl occurring from future OCS oil and gas operations in the Gulf of Mexico. Should a such a spill contact a recreational beach, short-term displacement of recreational activity from the areas directly affected would occur. Beaches directly impacted would be expected to close for periods of 2-6 weeks, or until the cleanup operations were complete. Should a spill occur, factors such as season, extent of pollution, beach type and location, condition and type of oil washing ashore, tidal action, and cleanup methods would have a bearing on the severity of effects the spill would have on a recreational beach and its use. Sorenson (1990) reviewed the economic effects of several historic major oil spills on beaches and concluded that a spill near a coastal recreation area would reduce visitation in the area by 5-15 percent over one season but would have no long-term effect on tourism.

The estimated annual oil spill occurrences expected in the future in the WPA or CPA, based on historical data maintained by MMS and USCG, are presented in Table 4-17. The great majority of coastal spills that do occur from OCS-related activities are likely to originate near terminal locations in the coastal zone around marinas, refineries, commercial ports, pipeline routes, and marine terminal areas, usually during the transfer of fuel. The average fuel-oil spill is 18 bbl. It is expected that these frequent, but small, spills will not affect coastal beach use.

Although hundreds of small spills are documented annually from all sources within the marine and coastal environment of the Gulf Coast, it is primarily large spills (≥1,000 bbl) that are a major threat to coastal beaches. Should a large spill impact major recreational beaches, no matter the source, it will result in unit and park closures until cleanup is complete. Oil-pollution events impacting recreational beaches will generate immediate cleanup response from responsible oil and gas industry sources. Recreational use will be displaced from impacted beaches and closed parks (generally 2-4 weeks). Recreational use and tourism impacts will be more significant if spills affect beaches during peak-use seasons and if publicity is intensive and far-reaching.

Summary and Conclusion

Debris and litter derived from both offshore and onshore sources are likely to diminish the tourist potential of beaches and to degrade the ambience of shoreline recreational activities, thereby affecting the enjoyment of recreational beaches throughout the area. The incremental beach trash resulting from the proposed actions is expected to be minimal.

Platforms and drilling rigs operating nearshore may affect the ambience of recreational beaches, especially beach wilderness areas. The sound, sight, and wakes of OCS-related and non-OCS-related vessels, as well as OCS helicopter and other light aircraft traffic, are occasional distractions that are noticed by some beach users.

Oil that contacts the coast may preclude short-term recreational use of one or more Gulf Coast beaches at the park or community levels. Displacement of recreational use from impacted areas will occur, and a short-term decline in tourism may result. Beach use at the regional level is unlikely to change from normal patterns; however, closure of specific beaches or parks directly impacted by a large oil spill is likely during cleanup operations.

4.5.13. Impacts on Archaeological Resources

The following cumulative analysis considers the effects of the impact-producing factors related to a proposed action, OCS activities in the cumulative activity area, trawling, sport diving, commercial treasure hunting, seismic exploration in State waters, and tropical storms on archaeological resources. Specific types of impact-producing factors associated with OCS activities that are considered in this analysis include drilling rig and platform emplacement, pipeline emplacement, anchoring, oil spills, dredging, new onshore facilities, and ferromagnetic debris.

4.5.13.1. Historic Archaeological Resources

Archaeological surveys are assumed to be highly effective in reducing the potential for an interaction between an impact-producing activity and a historic resource. The surveys are expected to be most effective in areas where there is only a thin veneer of unconsolidated Holocene sediments. In these areas shipwreck remains are more likely to be exposed at the seafloor where they can be detected by the side-scan sonar as well as the magnetometer. In areas of thicker unconsolidated sediments, shipwreck remains are more likely to be completely buried with detection relying solely on magnetometer. According to estimates presented in Table 4-4, an estimated 26,119-32,385 exploration, delineation and development wells will be drilled, and 2.987-3,999 production platforms will be installed as a result of the OCS Program. Of this range, between 10,774-12,131 exploration, delineation, and development wells will be drilled, and 2,239-2,969 production structures will be installed in water depths of 60 m or less. The majority of lease blocks in this water depth have a high probability for historic shipwrecks. Archaeological surveys were first required for Lease Sale 32 held in December 1973; therefore, it is assumed that any major impacts to historic resources resulted from development prior to this time.

Of the 15,886 lease blocks in the OCS Program area, less than half of these blocks are leased. There are 1,562 blocks that fall within the Gulf of Mexico Region's high probability areas for historic resources. Of these blocks, 1,189 blocks are in water depths of 200 m or less and will require a 50 m survey. The potential of an interaction between rig or platform emplacement and a historic shipwreck is greatly diminished by requisite site surveys, but still exists. Such an interaction could result in the loss of or damage to significant or unique historic information.

Table 4-4 indicates the placement of between 27,590-52,364 km of pipelines is projected in the cumulative activity area. While the required archaeological survey minimizes the chances of impacting a historic shipwreck, there remains a possibility that a wreck could be impacted by pipeline emplacement. Such an interaction could result in the loss of significant or unique historic information.

The setting of anchors for drilling rigs, platforms, and pipeline lay barges, and anchoring associated with oil and gas service-vessel trips to the OCS have the potential to impact historic wrecks. Archaeological surveys serve to minimize the chance of impacting historic wrecks; however, these surveys are not infallible and the chance of an impact from future activities does exist. Impacts from anchoring on a historic shipwreck may have occurred. There is also a potential for future impacts from anchoring on a historic shipwreck. Such an interaction could result in the loss of or damage to significant or unique scientific information.

The probabilities of offshore oil spills ≥1,000 bbl occurring from OCS Program activities is presented in Chapter 4.1.3. Oil spills have the potential to impact coastal historic sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. The impacts caused by oil spills to coastal historic archaeological resources are generally short term and reversible. Table 4-17 presents the coastal spill scenario from both OCS and non-OCS sources. It is assumed that the majority of the spills will occur around terminals and be contained in the vicinity of the spill. Should such oil spills contact a historic site, the effects would be temporary and reversible.

Most channel dredging occurs at the entrances to bays, harbors, and ports. These areas have a high probability for historic shipwrecks; the greatest concentrations of historic wrecks are likely associated with these features (Garrison et al., 1989). It is reasonable to assume that significant or unique historic archaeological information has been lost as a result of past channel dredging activity. In many areas, the COE requires remote-sensing surveys prior to dredging activities to minimize such impacts.

Past, present, and future OCS oil and gas exploration and development and commercial trawling will result in the deposition of tons of ferromagnetic debris on the seafloor. Modern marine debris associated with these activities will tend to mask the magnetic signatures of historic shipwrecks, particularly in areas that were developed prior to requiring archaeological surveys. Such masking of the signatures characteristic of historic shipwrecks may have resulted or may yet result in OCS activities in the cumulative activity area impacting a shipwreck containing significant or unique historic information.

Trawling activity specifically would only affect the uppermost portions of the sediment column (Garrison et al., 1989). On many wrecks, the uppermost portions would already be disturbed by natural factors and would contain only artifacts that have lost all original context.

Because MMS does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of the National Historic Preservation Act (NHPA) are enforcable by MMS in those areas. However, other Federal agencies, such as the COE, which issues permits associated with pipelines in State waters, are responsible for the protection of archaeological resources under the NHPA. Therefore, the impacts that might occur to archaeological resources by OCS-related pipeline construction within State waters should be mitigated under the requirements of the NHPA.

Sport diving and commercial treasure hunting are significant factors in the loss of historic data from wreck sites. Efforts to educate sport divers and to foster the protection of historic shipwrecks, such as, those of the Texas Historical Commission and the Southwest Underwater Archaeological Society (Arnold, personal communication, 1997), will serve to lessen these potential impacts. While commercial treasure hunters generally impact wrecks with intrinsic monetary value, sport divers may collect souvenirs from all types of wrecks. Since the extent of these activities is unknown, the impact cannot be quantified. A Spanish war vessel, *El Cazador*, was discovered in the Central Gulf of Mexico, which contained a large amount of silver coins and has been impacted by treasure hunting salvage operations (*The Times Picayune*, 1993). The historic data available from this wreck and from other wrecks that have been impacted by treasure hunters and sport divers represent a significant or unique loss.

Much of the coast along the northern Gulf was hit with 16-20 tropical cyclones between the years 1901 and 1955 (DeWald, 1982). Shipwrecks in shallow waters are exposed to a greatly intensified, longshore current during tropical storms (Clausen and Arnold, 1975). Under such conditions, it is highly likely that artifacts (e.g., ceramics and glass) would be dispersed. Some of the original information contained in the site would be lost in this process, but a significant amount of information would also remain. Overall, a significant loss of data from historic sites has probably occurred, and will continue to occur, in the northeastern Gulf from the effects of tropical storms. Some of the data lost have most likely been significant or unique.

Summary and Conclusion

Several impact-producing factors may threaten historic archaeological resources. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a historic shipwreck located on the continental shelf. The archaeological surveys and resulting archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities in a lease are expected to be highly effective at identifying possible historic shipwrecks. The OCS development prior to requiring archaeological surveys has possibly impacted wrecks containing significant or unique historic information.

The loss or discard of ferromagnetic debris associated with oil and gas exploration and development and trawling activities could result in the masking of historic shipwrecks.

Loss of significant or unique historic archaeological information from commercial fisheries (trawling) is not expected. It is expected that dredging, sport diving, commercial treasure hunting, and tropical storms have impacted and will continue to impact historic period shipwrecks. Additionally, it is possible that explosive seismic surveys on the OCS and within State waters, prior to 1989, could have impacted historic shipwrecks. Explosive seismic charges set near historic shipwrecks could have displaced the vessel's surrounding sediments acting like a small underwater fault and moving fragile wooden, ceramic and metal remains out of their initial cultural context. Such of an impact would have resulted in the loss of significant or unique archaeological information.

Onshore development as a result of a proposed action could result in the direct physical contact between a historic site and pipeline trenching. It is assumed that archaeological investigations prior to construction will serve to mitigate these potential impacts. The expected effects of oil spills on historic coastal resources are temporary and reversible.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the loss of significant or unique historic archaeological information. In the case of factors related to OCS Program activities in the cumulative activity area, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of the proposed actions is expected to be very small due to the efficacy of the required remote-sensing survey and archaeological report. However, there is a possibility of an interaction between bottom-disturbing activity (rig emplacement, pipeline trenching, and anchoring) and a historic shipwreck.

4.5.13.2. Prehistoric Archaeological Resources

Future OCS exploration and development activities in the Gulf of Mexico between 2003 and 2042 referenced in Table 4-4 project drilling 10,774-12,131exploration, delineation, and development wells in water depths <60 m. Relative sea-level curves for the Gulf of Mexico indicate there is no potential for the occurrence of prehistoric archaeological sites in water depths greater than 60 m. Archaeological surveys are assumed to be highly effective in reducing the potential for an interaction between an impact-producing activity and a prehistoric resource. Archaeological surveys were first required for Lease Sale 32 held in December 1973; therefore, it is assumed that the major impacts to prehistoric resources resulted from development prior to this time. The potential of an interaction between rig or platform emplacement and a prehistoric site is diminished by the survey, but still exists. Such an interaction would result in the loss of or damage to significant or unique prehistoric information.

The placement of 160-480 km and 160-320 km of pipelines in water depths <60 m is projected as a result OCS Program activities in the CPA and WPA, respectively. For the OCS Program, 9,800-24,374 km of pipelines are projected in water depths <60 m. While the archaeological survey minimizes the chances of impacting a prehistoric site, there remains a possibility that a site could be impacted by pipeline emplacement. Such an interaction would result in the loss of significant or unique archaeological information.

The setting of anchors for drilling rigs, platforms, and pipeline lay barges, and anchoring associated with oil and gas service vessel trips to the OCS have the potential to impact shallowly buried prehistoric sites. Archaeological surveys minimize the chance of impacting these sites; however, these surveys are not seen as infallible and the chance of an impact from future activities exists. Impacts from anchoring on a prehistoric site may have occurred. Such an interaction could result in the loss of significant or unique archaeological information.

The probabilities of offshore oil spills ≥1,000 bbl occurring from the OCS Program in the cumulative activity area is presented in Chapter 4.1.3. Oil spills have the potential to impact coastal prehistoric sites directly or indirectly by physical impacts caused by oil-spill cleanup operations. Coastal, oil-spill scenario numbers are presented in Table 4-17 for both OCS and non-OCS sources. It is assumed that the majority of the spills will occur around terminals and will be contained in the vicinity of the spill. There is a small possibility of these spills contacting a prehistoric site. The impacts caused by oil spills to coastal prehistoric archaeological resources can severely distort information relating to the age of the site.

Contamination of the organic site materials by hydrocarbons can make radiocarbon dating of the site more difficult or even impossible. This loss might be ameliorated by using artifact seriation or other relative dating techniques. Coastal prehistoric sites might also suffer direct impact from oil spill cleanup operations as well as looting resulting from interactions between persons involved in cleanup operations and unrecorded prehistoric sites. Interaction between oil-spill cleanup equipment or personnel and a site could destroy fragile artifacts or disturb site context, possibly resulting in the loss of information on the prehistory of North America and the Gulf Coast region. Some coastal sites may contain significant or unique information.

Most channel dredging occurs at the entrances to bays, harbors, and ports. Bay and river margins have a high probability for the occurrence and preservation of prehistoric sites. Prior channel dredging has disturbed buried and/or inundated prehistoric archaeological sites in the coastal plain of the Gulf of Mexico. It is assumed that some of the sites or site information were unique or significant. In many areas, the COE requires surveys prior to dredging activities to minimize such impacts.

Trawling activity would only affect the uppermost portion of the sediment column (Garrison et al., 1989). This zone would already be disturbed by natural factors, and site context to this depth would presumably be disturbed. Therefore, no effect of trawling on prehistoric sites is assumed. Investigations prior to construction can determine whether prehistoric archaeological resources occur at these sites.

Table 4-8 indicates the projected coastal infrastructure related to OCS Program activities in the cumulative activity area. Investigations prior to construction can determine whether prehistoric archaeological resources occur at these sites.

Because MMS does not have jurisdiction over pipelines in State waters, the archaeological resource protection requirements of the NHPA are not within MMS's jurisdiction. However, other Federal agencies, such as the COE, which lets permits associated with pipelines in State waters, are responsible for the protection of archaeological resources under the NHPA. Therefore, the impacts that might occur to archaeological resources by pipeline construction within State waters should be mitigated under the requirements of the NHPA.

About half of the coast along the northern Gulf was hit with 16-20 tropical cyclones between the years 1901 and 1955 (DeWald, 1982). Prehistoric sites in shallow waters and on coastal beaches are exposed to the destructive effects of wave action and scouring currents. Under such conditions, it is highly likely that artifacts would be dispersed and the site context disturbed. Some of the original information contained in the site would be lost in this process. Overall, a significant loss of data from prehistoric sites has probably occurred, and will continue to occur, in the northeastern Gulf from the effects of tropical storms.

Summary and Conclusion

Several impact-producing factors may threaten prehistoric archaeological resources of the Gulf of Mexico. An impact could result from a contact between an OCS activity (pipeline and platform installations, drilling rig emplacement and operation, dredging, and anchoring activities) and a prehistoric archaeological site located on the continental shelf. The required archaeological surveys and resulting archaeological analysis and clearance that are required prior to an operator beginning oil and gas activities in a lease are expected to be highly effective at identifying possible prehistoric sites. OCS development prior to requiring archaeological surveys has possibly impacted sites containing significant or unique prehistoric information.

The likelihood of an oil spill occurring and contacting the coastline is very high. Such contact could result in loss of significant or unique information from coastal prehistoric sites.

The initial dredging of ports and navigation channels and tropical storms are assumed to have caused the loss of significant archaeological information.

Onshore development as a result of the OCS Program could result in the direct physical contact between a prehistoric site and new facility construction and pipeline trenching. It is assumed that archaeological investigations prior to construction will serve to mitigate these potential impacts.

The shallow depth of sediment disturbance caused by commercial fisheries activities (trawling) is not expected to exceed that portion of the sediments that have been disturbed by wave-generated forces.

The effects of the various impact-producing factors discussed in this analysis have likely resulted in the loss of significant or unique prehistoric archaeological information. In the case of factors related to OCS Program activities in the cumulative activity area, it is reasonable to assume that most impacts would have occurred prior to 1973 (the date of initial archaeological survey and clearance requirements). The incremental contribution of the proposed actions is expected to be very small due to the efficacy of the required remote-sensing survey and concomitant archaeological report and clearance.

4.5.14. Impacts on Human Resources and Land Use

The cumulative analysis considers the effects of OCS-related, impact producing as well as non-OCS-related factors. The OCS-related factors consist of prior, current, and future OCS lease sales; non-OCS factors include fluctuations in workforce, net migration, relative income, oil and gas activity in State waters, wetland loss, and tropical storms. Unexpected events that may influence oil and gas activity within the analysis area but cannot be predicted are not considered in this analysis.

4.5.14.1. Land Use and Coastal Infrastructure

Chapters 3.3.3.1.2 and 3.3.3.8 discuss land use and OCS-related oil and gas infrastructure associated with the analysis area. Land use in the analysis area will evolve over time. While the majority of this change is estimated as general regional growth, activities associated with the OCS Program are expected to minimally alter the current land use of the area. Except for 4-16 projected new gas processing plants, the OCS Program will require no new oil and gas coastal infrastructure. There may be some expansion at current facilities, but the land in the analysis area is sufficient to handle development. There is also sufficient land to construct the projected new gas processing plants in the analysis area.

Shore-based OCS servicing should also increase in the ports of Galveston, Texas; Port Fourchon, Louisiana; and the Mobile, Alabama, area due to deepwater activities. There is sufficient land designated in commercial and industrial parks and adjacent to the Galveston and Mobile area ports to minimize disruption to current residential and business use patterns. Port Fourchon, though, has limited land available; operators have had to create land on adjacent wetland areas. Any changes in the infrastructure at Port Fourchon that lead to increases in Louisiana Highway 1 (LA Hwy 1) usage, will contribute to the increasing deterioration of the highway. LA Hwy 1 is not able to handle projected OCS activities. In addition, any changes that increase OCS demand of water will further strain Lafourche Parish's water system. In 2003, construction of Edison Chouest's C-Port at Galveston, Texas, to service the WPA and Mexico should be completed and fully operational. This service facility may act to distribute OCS impacts to onshore infrastructure. Other ports in the analysis area that have sufficient available land plan to make OCS-related infrastructure changes.

Since the State of Florida and many of its residents reject any mineral extraction activities off their coastline, OCS-focused businesses are not expected to be located there.

Summary and Conclusion

Activities relating to the OCS Program are expected to minimally affect the analysis area's land use. Most subareas in the analysis area have strong industrial bases and designated industrial parks to accommodate future growth in OCS-related businesses. Any changes (mostly expansions, except for the 4-16 projected new gas processing plants) are expected to be contained on available land. Port Fourchon is expected to experience significant impacts to its land use from OCS-related expansion. Increased OCS-related usage from port clients is expected to significantly impact LA Hwy 1 in Lafourche Parish. Also, increased demand of water by the OCS will further strain Lafourche Parish's water system.

4.5.14.2. Demographics

This section projects how and where future demographic changes will occur and whether they correlate with the OCS Program. The addition of any new human activity, such as oil and gas development resulting from the proposed actions, can effect local communities in a variety of ways. Typically, these effects are in the form of people and money that can translate into changes in the local social and economic institutions and land use.

Population

Chapter 3.3.3.4.1 discusses the analysis area's baseline population and projections. Population impacts from the OCS Program, Tables 4-59 and 4-60 mirror those assumptions associated with employment described below in Chapter 4.5.14.3. Projected population changes reflect the number of people dependent on income from oil and gas-related employment for their livelihood. This figure is based on the ratio of population to employment in the analysis area over the throughout the 40-year analysis period. Activities associated with the OCS Program are projected to have minimal effects on population in most of the coastal Subareas. Regions in Louisiana coastal subareas, the Lafourche Parish area in particular, are expected to experience noteworthy increases in population resulting from increases in demand for OCS labor. Chapter 4.5.14.3 below discusses this issue in more detail.

Age

The age distribution of the analysis area is expected to remain virtually unchanged with respect to OCS Program activities. Given both the low levels of population growth and industrial expansion associated with the OCS Program, the age distribution pattern discussed in Chapter 3.3.3.4.2 is expected to continue throughout the 40-year analysis period.

Race and Ethnic Composition

The racial distribution of the analysis area is expected to remain virtually unchanged with respect to the OCS Program. Given the low levels of employment and population growth and the industrial expansion projected for a proposed action, the racial distribution pattern described in Chapter 3.3.3.4.3 is expected to continue throughout the 40-year analysis period.

Education

Activities relating to the OCS Program are not expected to significantly affect the analysis area's educational levels described in Chapter 3.3.3.4.4. Some regions in the analysis area, Lafourche Parish in particular, will experience some strain to their education system, but the level of educational attainment will not be affected.

Summary and Conclusion

Activities relating to the OCS Program are expected to minimally affect the analysis area's demography. Baseline patterns and distributions of these factors, as described in Chapter 3.3.4, are not expected to change for the analysis area as a whole. Some regions within Louisiana coastal Subareas, Port Fourchon in particular, are expected to experience some impacts to population and their education system as of a result of increase demand of OCS labor.

4.5.14.3. Economic Factors

This cumulative economic analysis focuses on the potential direct, indirect, and induced impacts of the OCS Program's oil and gas activities in the Gulf of Mexico on the population and employment of the counties and parishes in the analysis area. The regional economic impact assessment methodology used to estimate changes to employment for a proposed lease sale was used for the cumulative analysis.

Tables 4-61 and 4-62 present employment associated with the OCS Program and the percentage to total employment in each coastal subarea. Based on these model results, direct employment associated with OCS Program activities is estimated to range between 55,000 and 74,000 jobs during peak activity years (year 2 through year 11) for the low and high resource estimate scenarios, respectively. There is no clear year of peak impact. Employment quickly grows to the peak, stays at relatively high levels from year 2 to year 11, and then gradually declines throughout the life of the proposal. Indirect employment is projected between 21,000 and 28,000 jobs, while induced employment is calculated between 25,000 and 33,000 jobs for the same peak period. Therefore, total employment resulting from OCS Program activities is not expected to exceed 101,000-136,000 jobs in any given year over the 40-year impact period.

In Texas, the majority of OCS-related employment is expected to occur in coastal Subarea TX-2; however, this employment is expected to exceed 1 percent but is never expected to exceed a maximum of 1.6 percent of the total employment in that coastal subarea. The OCS-related employment for all Louisiana coastal subareas is projected to be substantial. Employment in coastal Subarea LA-1 is projected to have the most significant impact in Louisiana and in the analysis area at 6.3 percent of total employment for that area. The OCS-related employment for coastal Subareas LA-2 and LA-3 is 3.3 and 3.9 percent of total employment, respectively. The OCS-related employment for Mississippi and Alabama's coastal Subarea MA-1 is not expected to exceed 1 percent of the total employment in that area. Model results also reveal there would be little to no economic stimulus to the Florida coastal subareas as a result of OCS Program activities. Population impacts, as conveyed in Tables 4-59 and 4-60, mirror those assumptions associated with employment.

Employment demand will be met primarily with the existing population and available labor force in most coastal subareas. The MMS does expect some employment will be met through in-migration due to the shadow effect and a labor force lacking requisite skills for the oil and gas and supporting industries. In addition, MMS expects sociocultural impacts to be minimal in most coastal subareas. Some localized impacts to family life in a small number of cases may result from the offshore work schedule of two weeks on and two weeks off.

On a regional level, the cumulative impact on the population, labor, and employment of the counties and parishes of the impact area is considerable for some focal points. Peak annual changes in the population, labor, and employment of all coastal subareas in the CPA and WPA resulting from the OCS Program are minimal, except in Louisiana. However, on a local level, Port Fourchon is experiencing full employment, housing shortages, and stresses on local infrastructure—roads (LA Hwy 1), water supply, schools, hospitals, etc. Port Fourchon is a focal point for OCS development, especially deepwater OCS operations. Any additional employment, particularly new residential employment, and the resultant strain on infrastructure, due to the OCS Program, are expected to have a significant impact on the area.

The resource costs of cleaning up an oil spill, either onshore or offshore, were not included in the above cumulative analysis. The cleanup and remediation of an oil spill involves the expenditure of millions of dollars and the creation of up to hundreds of temporary jobs. While such expenditures are revenues to business and employment/revenues to individuals, spills represent a net cost to society and are a deduction from any comprehensive measure of economic output. In economic terms, spills represent opportunity costs. An oil spill's opportunity cost has two generic components. The first cost is the direct cost to clean up the spill and to remediate the oiled area. This is the value of goods and services that could have been produced with these resources had they gone to production or consumption rather than the cleanup. The second is the value of the opportunities lost or precluded to produce (e.g., harvest oysters) or consume (e.g., recreational/tourism activities) (Pulsipher et al., 1999).

Chapter 4.4.1 discusses the risk of spill occurrence, the number of spills estimated for the OCS Program, and the likelihood of an OCS-spill contacting the Gulf Coast. The scenarios for the analysis are hypothetical spills of 4,600 bbl and ≥10,000 bbl occurring from future OCS oil and gas operations in the Gulf of Mexico. The magnitude of the impacts discussed below depend on many factors including the season of spill occurrence and contact, the volume and condition of the oil that reaches shore, the usual use of the shoreline impacted, the diversity of the economic base of the shoreline impacted, and the time required for cleanup and remediation activities. In addition, the extent and type of media coverage of a spill may affect the magnitude and length of time that tourism is reduced to an impacted area.

The immediate social and economic consequences for a region contacted by an oil spill also included non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations. These negative, short-term social and economic consequences of an oil spill are expected to be modest as measured by projected cleanup expenditures and the number of people employed in cleanup and remediation activities.

Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill (Pulsipher et al., 1999). Chapters 4.4.3.10 and 4.4.3.12 contain more discussions of the consequences of a spill on fisheries and recreational beaches.

Summary and Conclusion

The OCS Program will produce only minor economic changes in the Texas, Mississippi, and Alabama coastal subareas. With the exception of Subarea TX-2, it is expected to generate a less than 1 percent increase in employment in any of the coastal subareas in these states. Employment associated with the OCS Program only marginally exceeds 1 percent of total employment for coastal Subarea TX-2. There will be very little economic stimulus in the Florida coastal subareas assuming that the State of Florida remains in opposition to mineral extraction anywhere along its coastline. However, the OCS Program is projected to substantially impact the Louisiana coastal subareas. The OCS-related employment is expected to peak during the peak-activity years of 2004-2012 at 6.3 percent, 3.3 percent, and 3.9 percent of total employment for coastal Subareas LA-1, LA-2, and LA-3, respectively. On a regional level, activities relating to the OCS Program are expected to significantly impact employment in Lafourche Parish in Subarea LA-2. Therefore, the population, housing, roads (LA Hwy 1), water supply, schools, and hospitals in the parish will be affected and strained.

The short-term social and economic consequences for the Gulf coastal region should a spill $\geq$1,000 bbl occur includes opportunity cost of 363-1,183 person-years of employment and expenditures of \$20.7-\$67.5 million that could have gone to production or consumption rather than spill-cleanup efforts. Non-market effects such as traffic congestion, strains on public services, shortages of commodities or services, and disruptions to the normal patterns of activities or expectations are also expected to occur in the short-term. These negative, short-term social and economic consequences of an oil spill are expected to be modest in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities. Negative, long-term economic and social impacts may be more substantial if fishing, shrimping, oystering, and/or tourism were to suffer or were to be perceived as having suffered because of the spill. Overall employment projected for all OCS oil and gas activities, including employment in the oil-spill response industry, is projected to be substantial (up to 6.3% of baseline employment in some subareas).

4.5.14.4. Environmental Justice

This analysis addresses environmental justice concerns related to cumulative impacts. These concerns center on increases in onshore activity (such as employment, migration, commuter traffic, and truck traffic) and on additions to the infrastructure supporting this activity (such as fabrication yards, supply ports, and onshore disposal sites for offshore waste). The MMS estimates that OCS production in during 2003-2042 will range from between 15.493 and 22.428 BBO and 153.420 and 207.983 tcf of gas (Table 4-1). After addressing the effects to environmental justice of the OCS Program, this section analyzes the cumulative effects of non-OCS factors that affect environmental justice in the study area. This section also considers the contribution of a proposed action in the CPA and of a proposed action in the WPA to the cumulative impacts.

Chapter 3.3.3.5 describes the widespread and extensive OCS-support system and associated labor force, as well as economic factors related to OCS activities. The widespread nature of the OCS-related infrastructure serves to limit the magnitude of effects that a proposed action or the OCS Program may have on any particular community. The continuing and future OCS Program will serve mostly to maintain ongoing activity levels. Generally, effects will be widely yet thinly distributed across the Gulf Coast and will consist of slightly increased employment and even more slightly increased population. For the OCS Program, employment will increase less than 1 percent in Mississippi, Alabama, and coastal Subarea TX-1, and slightly more than 1 percent in Subarea TX-2. In Louisiana, employment impacts will be more substantial and is expected to peak during the peak-activity years of 2004-2012 at 6.3 percent, 3.3 percent, and 3.9 percent of total employment for coastal Subareas LA-1, LA-2, and LA-3, respectively. For most of the Gulf Coast, the OCS Program will result in only minor economic changes. Some places could experience elevated employment, population, infrastructure, and/or traffic effects because of local concentrations of fabrication and supply operations. Lafourche Parish, Louisiana, is one community where concentrations of industry activity and related employment are likely to strain the local infrastructure.

Environmental justice issues involve questions of disproportionate and negative effects on minority and low-income populations. In the cumulative OCS Program case, employment opportunities will increase slightly in a wide range of businesses over the entire Gulf Coast. These conditions preclude a prediction of where much of this employment will occur or who will be hired. Figures 3-15 and 3-16 provide distributions of census tracts of high concentrations of minority groups and low-income households. As stated in Chapter 3.3.3.10, pockets of concentrations of these populations scattered throughout the Gulf of Mexico coastal counties and parishes, most in large urban areas where the complexity and dynamism of the economy and labor force preclude a measurable effect. Low-income populations are almost exclusively minority and urban. Because the distribution of low-income and minority populations does not parallel the distribution of OCS-related industry activity, the effects of the cumulative OCS Program are not expected to be disproportionate with regard to minority and low-income populations.

The cumulative OCS Program's widespread economic effects on minority and low-income populations are not expected to be negative. Ongoing MMS research includes gathering information on race and employment. Offshore workers in the production sector are almost entirely male and white (Rosenberg, personal communication, 2001). Other sectors, such as the fabrication industry and support industries (e.g., trucking), do employ minority workers and provide jobs across a wide range of pay levels and educational/skill requirements (Austin et al., 2002a and b; Donato, 1998). A study of oil industry trends between 1980 and 1990 found that downsizing was concentrated in the production sector, hence it affected white male employment more than that of women or minorities (Singelmann, in press). Evidence also suggests that a healthy offshore petroleum industry also indirectly benefits low-income and minority populations. One MMS study in Louisiana found income inequality decreased during the oil boom and increased with the decline (Tolbert, 1995). Another MMS-funded study found that reemployment rates for poorly educated black and white women laid off in the closing of an plant in one rural Louisiana town were much higher than reemployment rates after similar closings elsewhere because Louisiana's oil industry had created a complex local economy (Tobin, 2001). While, except in Louisiana, the OCS Program is expected to provide little additional employment, it will have the effect of maintaining current activity levels, which is expected to be beneficial to low-income and minority populations.

Environmental justice often concerns infrastructure siting, which may have disproportionate and negative effects on minority and low-income populations. Since OCS lease sales help maintain ongoing levels of activity rather than expand them, no one sale will generate significant new infrastructure demand. Over the next 40 years, the cumulative OCS Program is expected to result in new pipeline landfalls, pipeline shore facilities, and gas processing plants. Because of existing capacity, no new waste disposal sites are projected for the cumulative case (Louis Berger Group, Inc., in preparation).

At present, there are 126 OCS-related pipeline landfalls and 50 OCS-related pipeline shore facilities in the GOMR. Pipeline shore facilities are small structures, such as oil metering stations, associated with pipeline landfalls. For the OCS Program, 23-38 new pipeline landfalls (Chapter 4.1.2.1.7) and 12-20 pipeline shore facilities (Chapter 4.1.2.1.5.1) are projected. The projections mirror the current distribution landfalls: 15-22 landfalls are projected for Louisiana, which currently has 106; 8-16 are projected for Texas, Mississippi, and Alabama, which currently have 20;,and none are projected for Florida. For Louisiana, 8-12 pipeline shore facilities are projected, currently there are 37; 2-6 are projected for Texas, Mississippi, and Alabama, which currently have 13; and none for Florida. As discussed in the environmental justice analysis for oil spills (Chapter 4.4.3.14.4), existing coastal populations are not generally minority or low-income. While several census tracts around Morgan City and in the lower Mississippi River delta area are identified as having 50 percent or greater minority populations (Figure 3-15), the coastal areas of these tracts, like Louisiana's coastline in general, are virtually uninhabited. Pipeline landfalls and their associated facilities will not disproportionately affect minority or low-income populations.

Generally, MMS does not address downstream activities, stopping the analysis at the point offshore product is mixed with onshore and/or imported products. The MMS projects 4-16 new gas-processing plants will be needed in support of the OCS Program over the next 40-years; this need will be due in part to the proposed actions addressed in this EIS. Unlike pipelines, the geographic distribution of projected gas-processing plants differs markedly from the current distribution, a reflection of the location of offshore reserves, available capacity in existing facilities, and onshore demand. Between 3 and 9 new gas-processing plants are projected for Louisiana, which currently has 28; up to 5 gas-processing plants are projected for Texas, Mississippi, and Alabama, which currently have 7. As described in Chapter 3.3, the Gulf's extensive OCS-related infrastructure is widely distributed. This distribution is based on economic and logistical considerations unrelated to the distribution of concentrations of minority or low-income populations. The MMS cannot predict and does not regulate the siting of future gas-processing plants. The MMS assumes that sitings of any future facilities will be based on the same economic, logistical, zoning, and permitting considerations that determined past sitings, and that they will not disproportionately affect minority and low-income populations.

Each OCS-related facility that may be constructed onshore must receive approval by the relevant Federal, State, county or parish, and involved communities. Each onshore pipeline must obtain similar permit approval and concurrence. The MMS assumes that any onshore pipeline construction will be approved only if it is consistent with appropriate land-use plans, zoning regulations, and other State/regional/local regulatory mechanisms. Should a conflict occur, MMS assumes that approval will not be granted or that appropriate mitigating measures will be enforced by the responsible political entities.

Chapters 3.3.3.5.1 and 3.3.3.10 describe Louisiana's extensive oil-related support system. As a result of the concentration of OCS-support infrastructure, Louisiana has experienced more employment effects than the other Gulf Coast States. In Louisiana, Lafourche Parish is likely to experience the greatest concentration, and is the community where the additional OCS-related activities and employment will be sufficiently concentrated to be significant and to affect and strain its local infrastructure. While the addition of a C-Port in Galveston, Texas, is expected to increase Texas's share of future effects, Louisiana is likely to continue to experience more effects than the other Gulf Coast States.

The concentrated socioeconomic impacts in Lafourche Parish are not expected to have disproportionate effects on minority and low-income populations for several reasons. The parish is not predominately low-income or minority (Figures 3-15 and 3-16). The Houma, a Native American tribe recognized by the State of Louisiana, have been identified by the MMS as a possible environmental justice concern. The MMS is funding a study focused on Lafourche Parish, the Houma, and other possible concerns, although existing information indicates that the Houma will not be disproportionately affected because they are not residentially segregated but, rather, live interspersed among the non-minority population (Fischer 1970).

Two local infrastructure issues described in Chapter 3.3.3.2 could possibly have related environmental justice concerns: traffic on LA Hwy 1 and Port Fourchon expansion. The most serious concern raised during scoping for this multisale EIS is high level of traffic on LA 1. Increased truck traffic destined for Port Fourchon physically stresses the highway, inconveniences and sometimes disrupts local communities, and may pose health risks in the form of increased accident rates and possible interference to hurricane evacuations (Keithly, 2001; Hughes, in preparation). As described in Chapter 3.1.1.1, the area's "string settlement pattern" means that rich and low-income alike live on a narrow band of high ground along LA 1 and will be equally affected by any increased traffic.

Port Fourchon is relatively new and mostly surrounded by uninhabited land. Existing residential areas close to the port are new and not low-income. While the minority and low-income populations of Lafourche Parish will share with the rest of the population the negative impacts of the OCS Program, most effects are expected to be economic and positive. While the link between a healthy oil industry and indirect economic benefits to all sectors of society may be weak in some communities, in Lafourche Parish it is strong. The Parish is part of an area of relatively low unemployment due to the concentration of petroleum industry activity (Hughes, in preparation).

Many studies of social change in the Gulf of Mexico coastal region suggest that the offshore petroleum industry, and even the offshore and onshore petroleum industry, has not been a critical factor except in limited in small areas for limited periods of time. This was a key conclusion of an MMS-funded study of the historical role of the industry in the Gulf, a study that addressed social issues related to environmental justice (Wallace et al., 2001). The MMS 5-Year Programmatic EIS (USDOI, MMS, 2001c) analyzed the contribution of the OCS program in the Gulf of Mexico (i.e., its cumulative effects) to the cumulative effects of both OCS and non-OCS factors affecting environmental justice. The MMS 5-Year Programmatic EIS notes that the characterization of the Gulf of Mexico's sociocultural systems suggests that the historical impacts of offshore oil and gas activities on the sociocultural environment have not been sweeping regional effects. Impacts, including how communities respond to fluctuations in industry activity, vary from one coastal community to the next. While regional impacts may be unnoticed or very limited, individual communities may or may not realize adverse sociocultural impacts. Expansion or contraction of offshore or onshore oil and gas activity has produced moderate impacts in some communities, whereas other communities have dealt with episodes of rapid industry change with negligible to minor impact. Further, non-OCS activities also have the potential for sociocultural impacts. These activities can lead to changes in social organization by being a catalyst for such things as in-migration, demographic shifts, population change, job creation and cessation, community development strategies, and overall changes in social institutions (family, government, politics, education, religion).

The MMS 5-Year Programmatic EIS analysis concludes that the cumulative environmental justice impacts from non-OCS activities have made, and will make, substantially larger contributions to the environmental justice effects than will the OCS Program.

Summary and Conclusion

Because of the presence of an extensive and widespread support system for OCS and associated labor force, the effects of the cumulative case are expected to be widely distributed and, except in Louisiana, little felt. In general, the cumulative effects of the OCS Program are expected to be economic and have a limited but positive effect on low-income and minority populations. In Louisiana, these positive economic effects are expected to be greater. In general, who will be hired and where new infrastructure might be located is impossible to predict, although a new C-Port in Galveston is likely to increase Texas's share of effects. Given the existing distribution of the OCS-related industry and the limited concentrations of minority and low-income peoples, the cumulative OCS Program will not have a disproportionate effect on these populations. Lafourche Parish will experience the most concentrated effects of cumulative impacts. Because the parish is not heavily low-income or minority and because the effects of road traffic and port expansion will not occur in areas of low-income or minority concentration, these groups are not expected to be differentially affected. In general, the more concentrated cumulative impacts in Lafourche Parish are expected to be mostly economic and positive. A proposed action in either the WPA or CPA is not expected to have disproportionate high/adverse environmental or health effects on minority or low-income people. In the Gulf of Mexico coastal area, the contribution of a proposed action and the OCS Program to the cumulative effects of all activities and trends affecting environmental justice issues over the next 40 years is expected to be negligible to minor. The cumulative effects will be concentrated in coastal areas, and particularly Louisiana. Most OCS Program effects are expected to be in the areas of job creation and the stimulation of the economy and are expected to make a positive contribution to economic justice. The contribution of the cumulative OCS Program to the cumulative impacts of all factors affecting environmental justice is expected to be minor (USDOI, MMS, 2001c).

4.6. Unavoidable Adverse Impacts of the Proposed Actions

The short-term uses of the environment considered in this Draft EIS and the cumulative development of OCS oil and gas resources in the Gulf of Mexico are compatible with the maintenance of long-term productivity. Unavoidable adverse impacts are anticipated to be primarily short-term and localized in nature.

Sensitive Coastal Habitats: If an oil spill were to contact a barrier beach, the removal of beach sand during cleanup activities could result in adverse impacts if the sand is not replaced. If an oil spill contacts coastal wetlands, adverse impacts could be high in localized areas. In some areas, wetland vegetation would experience suppressed productivity for several years. Much of the wetland vegetation would recover over time, but some wetland areas would be converted to open water. Unavoidable impacts resulting from maintenance dredging, wake erosion, and other secondary impacts related to channels would occur as a result of the proposed actions.

Sensitive Offshore Habitats: If an oil spill occurred and contacted sensitive offshore habitats, there would be some adverse impacts on organisms contacted by oil.

Water Quality: Routine offshore operations would have unavoidable effects to varying degrees on the quality of the surrounding water if the proposal is implemented. Drilling, construction, and pipelaying activities would cause an increase in the turbidity of the affected waters for the duration of the activity periods. A turbidity plume would also be created by the discharge of drill cuttings and drilling fluids. This, however, would only affect water in the immediate vicinity of the rigs and platforms. The discharge of treated sewage from the rigs and platforms would increase the levels of suspended solids, nutrients, chlorine, and BOD in a small area near the discharge point for a short period of time. Accidental spills from platforms and the discharge of produced waters could result in increases of hydrocarbon levels and trace metal concentrations in the water column in the vicinity of the platforms.

Unavoidable impacts to onshore water quality occurs as a result of chronic point- and nonpoint-source discharges such as runoff and effluent discharges from existing onshore infrastructure used in support of sale activities. Vessel traffic contributes to the degradation of impacted bodies of water through inputs of chronic oil leakage, treated sanitary and domestic waste, bilge water, and contaminants known to exist in ship paints. Regulatory requirements of the State and Federal water authorities and some local jurisdictions would be applicable to point-source discharges from support facilities such as refineries and marine terminals.

Air Quality: Unavoidable adverse impacts to air quality could occur onshore adjacent to crude oil refineries, gas processing plants, and areas of concentrated OCS-related activities. Unavoidable short-term impacts to air quality could occur near catastrophic events (e.g., oil spills and blowouts) due to evaporation and combustion. Mitigation of long-term effects would be accomplished through existing regulations and development of new control emission technology. However, short-term effects from nonroutine catastrophic events (accidents) are uncontrollable.

Endangered and Threatened Species: Unavoidable adverse impacts to endangered and threatened marine mammals, birds, sea turtles, mice, and the Gulf sturgeon due to activities associated with a proposed action (e.g., water quality and habitat degradation, helicopter and vessel traffic, oil spills and spill response, and discarded trash and debris) would be primarily sublethal. Lethal impacts to endangered species are expected to be rare.

Marine Mammals: Unavoidable adverse impacts to marine mammals due to activities associated with a proposed action (e.g., water quality degradation, helicopter and vessel traffic, oil spills and spill response, and discarded trash and debris) would be primarily sublethal. Lethal impacts to nonendangered and nonthreatened marine mammals are expected to be rare.

Coastal and Marine Birds: Some injury or mortality to coastal birds could result in localized areas from OCS-related oil spills, pipeline landfalls and coastal facility construction, helicopter and OCS service-vessel traffic, and trash and debris. Marine birds could be affected by noise and disturbances associated with offshore activities. If an oil spill occurs and contacts marine or coastal bird habitats, some birds could experience sublethal impacts, and some birds could experience lethal effects if they are coated with oil while feeding or resting. Oil spills and oil-spill cleanup activities could also affect local bird prey species.

Fish Resources and Commercial Fisheries: Losses to fishing resources and fishing gear could occur from production platform placement, oil spills, and produced-water discharges. Localized populations of fish species are expected to experience sublethal effects. This could result in a temporary decrease in a local population. It is unlikely that fishermen would harvest fish in the area of an oil spill, as spilled oil could coat or contaminate commercial fish species rendering them unmarketable. Other unavoidable adverse impacts include loss of fishing space caused by the installation of pipelines, rigs, platforms, or by other OCS-related structures.

Recreational Beaches: Even though existing regulations prohibit littering of the marine environment with trash, offshore oil and gas operations involving people at work, machines, equipment, and supplies may result in some contribution to floatable debris in the ocean environment. Debris may eventually come ashore on major recreational beaches. Accidents can lead to oil spills; larger spills ($\geq$1,000 bbl) may contact recreational beaches, causing them to become temporarily soiled by weathered crude oil.

Archaeological Resources: As a result of the proposed actions, unique or significant archaeological information may be lost. Required archaeological surveys significantly lower the potential for this loss by identifying potential archaeological sites prior to an impact, thereby making avoidance or mitigation of impacts possible. In some cases (e.g., in areas of high sedimentation rates), survey techniques may not be effective at identifying a potential resource.

4.7. Irreversible or Irretrievable Commitment of Resources

Irreversible or irretrievable commitments of resources refers to impacts or losses to resources that cannot be reversed or recovered. Examples are when a species becomes extinct or when wetlands are permanently converted to open water. In either case, the loss is permanent.

Wetlands: An irreversible or irretrievable loss of wetlands and associated biological resources could occur if wetlands are permanently lost due to impacts from dredging, construction activities, and oil spills. Dredging and construction activities can result in direct and indirect loss of wetlands, and oil spills can damage or destroy wetland vegetation, which leads to increased erosion and conversion of wetlands to open water. Construction and emplacement of onshore pipelines in coastal wetlands could result in the loss of coastal wetlands due to mechanical destruction and due to land loss facilitated by erosion of the marsh soils.

Sensitive Offshore Resources: Oil spills and chronic low-level pollution can injure and kill organisms at virtually all trophic levels. Mortality of individual organisms can be expected to occur, and possibly a reduction or even elimination of a few small or isolated populations. The proposed biological stipulations, however, are expected to eliminate most of these risks.

Fish Resources and Commercial Fisheries: Structure removal by explosives causes mortality to fish resources, including commercial and recreational species. Fish kills, including such valuable species as red snapper, are known to occur when explosives are used to remove structures in the Gulf of Mexico. If structure removal by explosives is continued, it will adversely impact the commercial fishing industry proximate to the removal site. However, in view of the positive impact of offshore platforms to fish resources and commercial fishing as a result of the platforms serving as artificial reefs and fish attracting devices, continued structure removal, regardless of the technique used, would reduce the net benefits to commercial fishing due to the presence of these structures.

Recreational Beaches: Beached litter, debris, oil slicks, and tarballs may result in decreased enjoyment or lost opportunities for enjoyment of coastal recreational resources.

Archaeological Resources: Although the impact to archaeological resources as a result of a proposed action is expected to be low, any interaction between an impact-producing factor (drilling of wells, emplacement of platforms, subsea completions, and pipeline installation) and a significant historic shipwreck or prehistoric site could destroy information contained in the site components and in their spatial distribution. This could cause a permanent loss of potentially unique archaeological data.

Oil and Gas Development and Production: Leasing and subsequent development and extraction of hydrocarbons as a result of the proposed actions would represent an irreversible and irretrievable commitment of nonrenewable oil and gas resources. The estimated amount of resources to be recovered as a result of the proposed actions is presented in Table 4-1.

Loss of Human and Animal Life: The OCS oil and gas exploration, development, production, and transportation are carried out under comprehensive, state-of-the-art, enforced regulatory procedures designed to ensure public safety and environmental protection. Nonetheless, some loss of human and animal life is inevitable from unpredictable and unexpected acts of man and nature (accidents, human error and noncompliance, and adverse weather conditions). Some normal and required operations, such as structure removal, can result in the destruction of viable marine life. Although the possibility exists that individual marine mammals, marine turtles, birds, and fish can be injured or killed, there is unlikely to be a lasting effect on baseline populations.

4.8. RELATIONSHIP BETWEEN THE SHORT-TERM USE OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

In this section, the short-term effects and uses of various components of the environment in the vicinity of proposed actions are related to long-term effects and the maintenance and enhancement of long-term productivity.

Short-term refers to the total duration of oil and gas exploration and production activities, whereas long-term refers to an indefinite period beyond the termination of oil and gas production. The specific impacts of the proposed actions vary in kind, intensity, and duration according to the activities occurring at any given time. Initial activities, such as seismic surveying and exploration drilling, result in short-term, localized impacts. Development drilling and well workovers occur sporadically throughout the life of the proposed actions, but also result in short-term, localized impacts. Activities during the production life of a platform may result in chronic impacts over a longer period of time (25-35 years), potentially punctuated by more severe impacts as a result of accidental events. Platform removal is also a short-term activity with localized impacts; the impacts of site clearance may be longer lasting. Over the long-term, several decades to several hundreds of years, natural environmental balances are expected to be restored.

Many of the effects discussed in Chapters 4.2 and 4.3 are considered to be short-term (being greatest during the construction, exploration, and early production phases). These impacts could be further reduced by the mitigative measures discussed in Chapter 2.

The principal short-term use of the leased areas in the Gulf would be for the production of 0.276-0.654 billion barrels of oil (BBO) and 1.590-3.300 trillion cubic feet (tcf) of natural gas from a typical proposed action in the CPA and 0.136-0.262 BBO and 0.810-1.440 tcf of natural gas from a proposed action in the WPA. The short-term recovery of hydrocarbons may have long-term impacts on biologically sensitive offshore areas or archaeological resources.

The OCS activities could temporarily interfere with recreation and tourism in the region, in the event of an oil spill contacting popular tourist beaches. The proposed leasing may also result in onshore development and population increases that could cause very short-term adverse impacts to local community infrastructure, particularly in areas of low population and minimal existing industrial infrastructure (Chapters 4.2.1.14 and 4.3.1.12). A return to equilibrium could be quickly expected as population changes and industrial development are absorbed in expanded communities. After the completion of oil and gas production, the marine environment is generally expected to remain at or return to its normal long-term productivity levels. To date, there has been no discernible decrease in long-term marine productivity in OCS areas where oil and gas have been produced for many years; in some circumstances, such as at rigs-to-reefs sites, productivity has increased. Areas such as the Atlantic coast, which experienced repeated incidents of oil pollution as a result of tanker torpedoings and groundings during World War II, show no apparent long-term productivity losses, although baseline data do not exist to verify this. In other areas that have experienced apparent increases in oil pollution, such as the North Sea, some long-term effects do appear to have taken place. Populations of pelagic birds have decreased markedly in the North Sea in recent years—prior to the beginning of North Sea oil production. Until more reliable data become available, the long-term effects of the chronic and major spillage of hydrocarbons and other drilling-related discharges cannot be accurately projected. In the absence of such data, it must be concluded that the possibility of decreased long-term productivity exists as a result of the proposed actions.

The OCS development off Louisiana and Texas has enhanced recreational and commercial fishing activities, which in turn has stimulated the manufacture and sale of larger private fishing vessels and special fish recreational equipment. Commercial enterprises such as charter boats have become heavily dependent on offshore structures for satisfying recreational customers. The proposed actions could increase these incidental benefits of offshore development. Offshore fishing and diving has gradually increased in the past three decades; platforms have been the focus of much of that activity. As mineral resources become depleted, platform removals would occur and may result in a decline in these activities. To maintain the long-term productivity of site-specific, artificial reefs attractive to fishermen and divers may need to eventually replace removed platforms.

Short-term environmental socioeconomic impacts could result from the proposed actions, including possible short-term losses in productivity as a result of oil spills. Long-term adverse environmental impacts would not be expected because archaeological regulations and the proposed biological stipulations are proposed as part of the proposed actions. However, some risk of long-term adverse environmental impacts remains due to the potential for accidents. No long-term productivity or environmental gains are expected as a result of the proposed actions; the benefits of the proposed actions are expected to be principally those associated with a medium-term increase in supplies of domestic oil and gas. While no reliable data exist to indicate long-term productivity losses as a result of OCS development, such losses are possible.